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POSTURAL METHOD OF DRAINING THE PERITONEAL CAVITY AFTER ABDOMINAL OPERATIONS.

By J. G. Clark, M. D.

The general trend of recent medical literature relating to intraperitoneal drainage through the abdominal incision has been towards the limitation or reduction of the number of conditions demanding its employment, and a few European gynecologists have even gone so far as to discard drainage entirely, leaving the peritoneum to protect itself.

In a forthcoming article* on drainage based upon the bacteriological study of a large number of cases and upon the clinical records of 1700 cases of abdominal section performed in the gynecological department of the Johns Hopkins Hospital, I have been forced, notwithstanding my preconceived ideas in favor of drainage, to draw conclusions against it and to coincide with those few writers who discard it altogether.

The benefits to be derived from any form of drainage when used for the purpose of removing infectious matter from the peritoneal cavity, are infinitesimal compared with the untoward or disastrous results which may follow its use.

The greatest safety lies in closing the abdomen without drainage, except in cases of purulent peritonitis or in operations when there has been extensive suturing of the intestines, and in a few other rare conditions which I shall consider in detail in my paper on drainage.

Escape of pus during an operation, oozing of blood or serum, extensive raw areas in the pelvis, are usually supposed to indicate the necessity of some form of drain; on the contrary, these are the cases which should be left to the care of the peritoneum, as demonstrated by a comparative study in our series of 1700 cases of abdominal section of a hundred cases each of similar pelvic inflammatory affections, drained and undrained. The undrained cases presented by far the best results.

Every surgeon recognizes the dangers of dead spaces in the abdominal cavity and endeavors to prevent their formation, but frequently this is impossible. Mikulicz first called attention to this subject in a forcible paper, and devised a special drain for the prevention of oozing and for the removal of fluids from dead spaces; but this method, like all others, is unsatisfactory because the principle upon which it is based is wrong.

In an article (1889) by Lande the statement is made that it is not the principle but the methods of drainage which are wrong. I would reverse this statement by saying that it is not the method but the principle which is wrong. Zweifel claims that the subject of drainage should no longer be considered in surgical treatises, but should be relegated to medical history.

The chief objections to drainage of dependent pockets in the pelvis or abdomen through an abdominal opening are, first, fluids are frequently not removed, but on the contrary are pent up by the gauze drain; and second, instead of removing infection, the gauze or tube may be the means of introducing it from the outside into the degenerated fluids.

*A Critical Review of 1700 Cases of Abdominal Section from the Standpoint of Intraperitoneal Drainage. The Johns Hopkins Hospital Reports, Vol. VII.

To overcome the dangers of dependent pockets and dead spaces in the pelvis, I would suggest the elevation of the patient's body after operation to a sufficient height to start the flow of collecting fluids from the pelvis towards the diaphragm, and thus promote the rapid elimination by the normal channels of exit from the peritoneal cavity, of infectious matter and of vital fluids which may stagnate in these pockets and form a culture medium for pyogenic micro-organisms.

Although it would appear at first sight that this method of drainage is opposed to sound surgical principles, I hope to offer proof from a review of recent literature bearing upon the function of the peritoneum under normal and pathological conditions, sustained by the clinical report of three cases, that it is not only a safe but may be a life-saving measure.

Function of the Peritoneum under Normal and Pathological Conditions.

G. Wegner,* the first investigator who by experiments upon animals endeavored to arrive at some definite conclusion concerning the ability of the peritoneum to rid itself of injurious fluids or solid particles, was convinced that a comparatively large quantity of infectious matter could be eliminated or encapsulated by the peritoneal exudate without serious harm to the animal.

Grawitz† next took up the experimental study of infection of the peritoneum, pursuing his investigations under improved bacteriological technique, and arrived at the following conclusions:

1. The introduction of non-pyogenic organisms into the abdominal cavity, either in small or large quantity, or mixed with formed particles,‡ produces no harm.

2. Great quantities of organisms which ordinarily produce no symptoms, may give rise to a general sepsis if the absorptive function of the peritoneum is impaired.

3. Injection of pyogenic organisms into the peritoneal cavity may be quite as harmless as injections of non-pathogenic varieties. (In these experiments he injected a flocculent emulsion of staphylococcus albus and aureus and the streptococcus pyogenes in ten cubic centimeters of water without any visible reaction.)

4. The introduction of pus-producing cocci into the normal peritoneal cavity produces a purulent peritonitis, first, if the culture fluid is difficult of absorption, and second, if irritating materials are present which destroy the tissues of the peritoneum, thus preparing a place for the lodgment of the organisms, and the production of an exudate upon which they may grow.

Pawlowsky,§ in an excellent experimental study, reviewed Wegner's and Grawitz's work, with whom he agreed in many particulars, but disagreed in others. The main point of difference, however, between Pawlowsky and Grawitz related to the ability of the normal peritoneum to deal with the staphylococcus aureus.

Pawlowsky found that the large quantities of staphylococci injected by Grawitz without harm into dogs produced death very rapidly in the animals upon which he experimented, and that only a minimum quantity was harmless.

Reichel* went over the same ground in an experimental research, and in the main agreed with Grawitz. The essential points of value in Reichel's paper are, that peritonitis usually arises, first, because more organisms gain entrance than can be handled by the peritoneum, and second, because the stagnation of degenerating fluids in dead spaces favors the growth of the organisms.

He also accounts for Grawitz's and Pawlowsky's conflicting results, on the ground that some animals are more susceptible to infection than others, and that there are marked differences in the virulence of cultures of the same organism under varying conditions.

A carefully conducted experimental research by Waterhouse,† carried out under the oversight of Orth, appears to me to satisfactorily settle the question of the ability of the normal peritoneum to take care of infection.

He injected 6 cc. of a cloudy culture of staphylococcus aureus into the abdominal cavity of dogs, employing both the methods of Grawitz and Pawlowsky, and all of the animals survived. The same results were obtained with the streptococcus, bacillus pyocyaneus and the intestinal bacteria.

Waterhouse then endeavored to simulate the conditions occasionally met with after operations, by introducing 8 cc. of urine and small quantities of blood with the cultures, and again the results were negative. If, however, 15 to 20 cc. of fresh blood were introduced into the peritoneal cavity, followed in a few minutes by the staphylococcus aureus, severe peritonitis was produced.

In these experiments Waterhouse agreed with Pawlowsky and Grawitz that the dangers of peritonitis are increased by tardy absorption of fluids, which in effect leaves a culture medium for the growth of the organisms.

After the introduction of blood clots 3 cm. in size, followed by the staphylococcus aureus, death occurred from peritonitis in 24 hours.

Waterhouse also found that the purulent exudate from acute abscesses is extremely virulent, 2 cc. of the staphylococcus aureus and 1 cc. of the streptococcus from this source causing death in twenty-four hours. If a very small quantity of the pus, however, was introduced with water, the animals frequently survived.

After the introduction of turpentine with the organisms, as done in Grawitz's experiments, peritonitis did not follow, which is explained by Waterhouse on the ground that the organisms are rendered inactive or are killed by the turpentine. He proved this point by injecting the turpentine first

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* Chirurgische Beobachtungen über die Peritonealhöle mit besonderer Berücksichtigung der Ovariotomie. Verhandlung der deutschen Gesellschaft für Chirurgie, Berlin, 1877.

† Charite Annalen Jahrg., XI, 1886.

‡ A solution of fecal matter containing solid particles was injected; the fluid was absorbed while the larger particles were encapsulated.

§ Virchow's Archiv, No. 117, p. 469, 1889.

* Beiträge zur Aetiologie u. chirurg. Therapie der Sup. Peritonitis. Deutsche Zeit. f. Chir., Vol. XXX, 1889.

† Virchow's Archiv, Vol. 119, p. 342, 1890.

and following it in a short time with the infecting germs; in every instance the animal died of peritonitis.

Dogs with a strangulation of the intestines were easily infected.

In three instances the staphylococcus aureus was introduced into the peritoneal cavity of cats suffering from ascites, followed quickly by death from peritonitis, which resulted, as Waterhouse says, because there was a favorable culture material, a diminished absorption, and an injury to the peritoneal endothelium.

Burginsky* in a series of experiments also came to the conclusion that the discrepancies in the results of Pawlowsky's and Grawitz's experiments were due to variations in the virulence of the cultures employed.

Halsted† confirmed and extended the views of previous observers concerning the resistance of the normal peritoneum to infection, and called attention to the dangers of introducing pyogenic organisms about a ligated or strangulated area, or in conjunction with insoluble bodies. Pieces of sterile potato introduced into the peritoneal cavity of control animals were soon encapsulated and produced no disturbance, but when infected with pyogenic cocci, invariably caused peritonitis.

A recent paper by Cobbett and Melsome,‡ on "Local and General Immunity," contains some valuable observations bearing upon the resistance of the peritoneum to infection.

Notwithstanding the injection of large quantities of virulent streptococci, a few of their animals survived. They state that "in those animals which succumbed quickest, free cocci were very numerous in the peritoneal exudation, and in those which survived longest they were either absent or contained within phagocytes."

These observers, in order to discover how quickly the organisms disappeared from the peritoneal cavity, killed two rabbits which appeared about to recover. "In the first, which had received 5 cc. of broth culture thirty hours before, only one chain of streptococci was found after prolonged search, but many cocci were contained in cells, and broth inoculated with this fluid grew a good culture."

"The second rabbit having shown no signs of illness after an injection of 6 cc. of anaerobic broth culture, received next day 10 cc. of a similar material swarming with streptococci. When killed five and a half hours later, not only could no streptococci be seen, either free or in cells, but no growth grew on cultures made from the abdominal fluid."

From this review of the literature bearing upon infection of the peritoneum I make the following summary:

1. Under normal conditions the peritoneum can dispose of large numbers of pyogenic organisms without producing peritonitis.

2. The less the absorption from the peritoneal cavity the greater the danger of infection.

3. Solid sterile particles, such as fecal matter, potato, etc., are partly absorbed and the remainder are encapsulated without the production of peritonitis.

4. Death may be produced by general septicæmia, and not by peritonitis, where large quantities of organisms are taken up by the lymph streams.

5. Irritant chemical substances destroy the tissues of the peritoneum and prepare a place for the lodgment of organisms which becomes the starting-point for peritonitis.

6. Stagnation of fluids in dead spaces favors the production of peritonitis by furnishing a suitable culture medium for the growth of bacteria.

7. The association of infectious bacteria with blood clots in the peritoneal cavity is especially liable to produce peritonitis.

8. Traumatic injury or strangulation of large areas of tissue are strong etiological factors in the production of peritonitis when associated with infectious matter.

The accumulated evidence of all these investigators proves beyond question that the peritoneum, under normal conditions or even when greatly handicapped by disease or artificial conditions, is capable of overcoming the invasion of comparatively large quantities of pyogenic bacteria.

Mechanism of Absorption of Fluids and Solid Particles in the Peritoneal Cavity.

Recent investigations by Muscatello* on the histology of the diaphragmatic peritoneum and the mechanism of absorption of substances from the peritoneal cavity, when considered in conjunction with the above conclusions, give ample ground for my suggestion of the elevated posture as a prophylactic measure against post-operative peritonitis.

Muscatello accepts Bizzozero's and G. Salvioli's classification of the component parts of the diaphragmatic peritoneum which occur in the following order: endothelium, membrana limitans and connective tissue framework. Up to the time of Muscatello's publication, histologists were equally divided on the question of the presence or absence of stomata between the endothelium. He proved beyond doubt that these openings are optical illusions, due to the defective preparation and staining of the microscopical sections. According to Muscatello's opinion, minute foreign particles, leucocytes and fluids pass through openings between the endothelium of the diaphragm made by the retraction of the protoplasm of the cells.

Beneath the peritoneal endothelium of the diaphragm and between the connective tissue fibres are open spaces 4 to 16 mm. in diameter, occurring in groups of 50 to 60, which communicate with the lymph vessels. A careful search for these spaces failed to reveal them in any other portion of the peritoneum.

G. Wegner first proved that the peritoneum was capable of absorbing the most remarkable quantities of fluids, equivalent to three to eight per cent of the bodily weight in one hour, or the animal's entire weight in twenty-four hours.

By the injection of foreign particles suspended in a fluid medium into the peritoneal cavities of dogs, Muscatello was able to demonstrate the existence of an intraperitoneal current which carried fluids and small particles towards the diaphragm, regardless of the animal's posture. The rate of transmission

* Baumgarten's Jahresbericht, Vol. VII, 1891.
† The Johns Hopkins Hospital Reports, Vol. II, 1891.
‡ Journal of Pathology and Bacteriology, 1895.

* Virchow's Archiv, 1895.

of the foreign particles from the peritoneal cavity to their ultimate repository, the lymph glands, could, however, be increased or retarded by the influence of gravity.

In those dogs which were suspended with head down, carmine bodies appeared in the retrosternal and thoracic lymph glands in from five to seven minutes, while in animals in which the posture was reversed it was five and a half hours before they could be recovered from these glands.

Muscatello proved that small particles were carried from the peritoneal cavity into the lymph spaces of the diaphragm through the opening made by the retraction of the endothelium, then into the mediastinal lymphatic vessels and glands, then into the blood current, by which they were transported to the various organs of the body, from which they were picked up by the lymph vessels and deposited in the collecting glands of each organ. For this reason the large vascular organs, such as the liver, stomach, spleen and pancreas, show the particles first and in the greatest numbers, while the lymph glands of the mesentery, which gather their vessels from a limited area of the intestine, contain but few of the granules.

The function of the leucocyte is of especial importance in the elimination of foreign particles from the peritoneal cavity.

Muscatello and other observers find, on examining the precipitate in the peritoneal cavity after injecting innocuous foreign particles or bacteria, wandering cells interspersed among the particles, some of which are lightly laden with granules, while others are apparently distended to the point of bursting, and still others which have not yet taken up their burdens.

In some instances where the granules are too large for one leucocyte to encompass it, two or more join forces to surround the invader. The leucocytes are found in greatest abundance beneath the omentum. From the peritoneal cavity Muscatello traces the course of the leucocyte through the channels above described and finally finds them deposited in the lymph glands in various parts of the body.

In Muscatello's experiments the leucocytes were able to dispose of the innocuous particles rapidly and without apparent ill effect to the animals. In Pawlowsky's, Cobbett's and Melsome's experiments, on the other hand, the conditions were different, the leucocyte having to meet an antagonistic invader. In those animals which survived the injection the infectious organisms were quickly encompassed by the leucocytes and carried into the general circulation, while in the fatal cases the peritoneal exudate was found swarming with free organisms and only a comparatively few enclosed in leucocytes.

The points in Wegner's and Muscatello's articles which I wish to draw especial attention to are:

1. Large quantities of fluids may be absorbed by the peritoneum in a remarkably short time. (Wegner.)

2. Minute foreign particles are carried from the peritoneal cavity through the diaphragm into the mediastinal lymph vessels and glands, and thence into the blood, by which they are transmitted to the organs of the body, especially those of the abdomen, and later appear in the collecting lymph glands of these organs. (Muscatello.)

3. The leucocytes are largely the bearers of foreign particles from the peritoneal cavity. (Muscatello.)

4. There is normally a current in the peritoneal cavity which carries fluids and foreign particles towards the diaphragm, regardless of the posture of the animal, although gravity can greatly favor or retard it. (Muscatello.)

Postural Method of Draining Dead Spaces in the Pelvis.

The many bacteriological studies in cases of experimental and post-operative peritonitis and in experimental infections of the peritoneum show conclusively that the infecting organisms are quickly distributed more or less generally in the peritoneal cavity, from whence they are carried into the system at large.

Where there is no persistent source of infection, virulent species of bacteria may be destroyed effectually in this way; but when a nidus of infection exists in which the micro-organisms are propagated, the patient is either carried off by a rapidly fatal septicæmia or peritonitis, or the peritoneal exudate forms a barrier to the further distribution of the infectious matter, which then follows the clinical course of any localized collection of pus.

To avoid this danger the most scrupulous care should be observed in every abdominal operation not to leave behind any condition which may furnish a starting point for an infectious process.

Oozing should be controlled as far as possible, injury and exposure of the peritoneum should be guarded against, raw areas should be covered with adjacent healthy peritoneum when practicable, and all debris and fluids should be removed as far as possible before the abdomen is closed.

Notwithstanding every precaution, dead spaces will be left after many operations, which may become collecting places for degenerating fluids. In addition to these artificial spaces, oozing serum and blood may collect in Douglas' cul-de-sac or in the ante-uterine space, and become the focus of a general peritonitis or a localized pelvic abscess.

To offset these dangers all dependent spaces should be drained as rapidly as possible, thus preventing the collection and stagnation of vital fluids, which are active germicides when first secreted, but become excellent culture media when degenerated.

By elevating the pelvis after operation, the normal intra-peritoneal current may be assisted greatly in at once draining dead spaces, and thus give the general peritoneal cavity and system at large the best opportunity to meet the invading organisms before they have had time to increase in numbers. To remind one of the incredible rate of multiplication of micro-organisms it is only necessary to quote Cohn's classical statement that "one germ under proper conditions may give rise to more than a half million of similar organisms within twenty-four hours."

Stagnating fluids in the dependent parts of the abdominal cavity or in dead spaces may furnish such a favorable culture bed that a few organisms may quickly generate myriads of others and overcome the most resistant germicidal forces; if on the other hand these spaces can be prevented from filling with fluids the organisms may easily be overcome.

In addition to the mere transportation of the organisms from an area of decreased resistance to one of normal resistance, the irritant chemical toxines elaborated by the bacteria are diluted and the infectious matter is divided into a fine granular state, thus giving the leucocytes the best opportunity to encompass the organisms.

Although fatal septicæmia may be produced in animals by the absorption of large quantities of organisms from the peritoneal cavity, it appears to me correct to assume that after a well-conducted abdominal operation no such quantities of organisms will be left behind as are necessary to produce septicæmia in the animal experimentally. If such a condition should exist the patient would certainly die from the rapid multiplication of the organisms in dependent cavities. Hence I conclude that the better chance for the patient's recovery lies in the direction I have indicated.

My arguments therefore in support of this postural method of drainage are, first, stagnating fluids are prevented from collecting in dead spaces in the pelvis; second, infectious organisms are quickly carried into normal areas of the body where they are destroyed before they can increase in numbers; and third, toxic substances elaborated by the organisms are diluted and prevented from expending their irritant effects on a wounded area.

The method which I desire to offer is briefly as follows: At the conclusion of an operation all fluids and debris should be removed as far as possible by sponges, after which the abdominal cavity should be thoroughly irrigated with normal salt solution until the fluid comes away clear.

When the irrigation fluid is all sponged out, 500 to 1000 cc. of salt solution should be poured into the peritoneal cavity, so that when the patient is elevated after she is returned to the ward the artificial current may be started at once towards the diaphragm, thus supplementing the normal current.

After the introduction of the salt solution the omentum and intestines should be replaced in an orderly way and the abdomen closed.

As soon as the patient is returned to her room, the foot of the bed should be elevated about 20 degrees, which gives sufficient inclination of the posterior pelvic wall to assist the flow towards the general peritoneal cavity. This posture should be maintained for twenty-four to thirty-six hours, after which the bed may be lowered.

Leaving the salt solution in the abdominal cavity is not a novel procedure, as it has been done in a large number of cases during the last two years in the gynecological department, and other abdominal surgeons have used it with good effect.

This postural method of drainage is offered as a prophylactic measure against post-operative peritonitis, but *not as a curative measure after the peritonitis is established.*

It should therefore not be employed when an operation is performed for the relief of purulent peritonitis or for inflammatory conditions associated with general peritonitis, as for instance some cases of appendicitis.

From the experiments of Waterhouse in which he proved the danger of infection in cats suffering with ascites on account of the defective absorptive mechanism, it would also appear unsafe to adopt the postural method in cases when this complication is coincident with the surgical affection. Pawlowsky has shown in his excellent experimental investigations that the lymph channels leading from the peritoneal cavity are choked with the infectious bacteria and inflammatory products in purulent peritonitis, and therefore advises free drainage through an abdominal incision.

In these cases it is evident that the multiplication and virulence of the organism have been too great for the phagocytes to overcome successfully, and that the only method of treating this condition is to remove as much pus as possible by irrigation with salt solution or by mopping the peritoneal surfaces with sponges wet with salt solution, as suggested by Finney, and then to insert a very free drain.

Only one of the cases which I report in this paper showed organisms on culture. The presence of pyogenic organisms is not a contraindication to the employment of the postural method, because all investigations have proved conclusively that the peritoneum can overcome the invasion of large numbers of the most virulent organisms. Cases of pelvic inflammatory diseases, however, rarely come to operation while the organisms are yet active, as shown by Miller of the Johns Hopkins Hospital, Schauta, Menge and others.

In forty-four cases of hysterectomy, mostly for pelvic inflammatory disease, examined by Miller, the cultures made from the interior of the uterus were negative, and cultures from the pus obtained from 51 cases of pyosalpinx, ovarian abscess and pelvic abscess, were negative in all but one case which showed gonococci.

Report of Cases in which the Postural Method of Drainage was employed.

Case I.

In this case all of the conditions usually supposed to indicate imperatively the employment of some one of the established methods of abdominal drainage were present.

Among these the chief indications were a septic temperature with great prostration of the patient before operation, and during the operation the separation of wide-spread adhesions which produced extensive injury to the peritoneum and free oozing of blood, the escape of a large quantity of pus and degenerated blood clots into the abdominal cavity. In addition to these conditions portions of the cyst wall and degenerated matter, and, most dangerous of all, a large cup-shaped dead space beneath the intestines and mesentery, were left at the close of the operation.

Gynecological No. 4946. E. B. L., admitted January 18, 1897. Married, age 47 years.

Complaint. Pain in the lower abdomen, more marked on the right side. Slight cough.

Marital History. Married 16 years; one child 16 years old; labor easy, puerperium normal, no miscarriage.

Menstruation. Began at 13 years, regular, normal. Last period terminated December 18, 1896.

Present Illness. November 15, 1896, she had a severe chill, lasting two hours, followed by fever. The next day she had great pain, which continued one week and was accompanied with diarrhœa. Since then she has grown steadily weaker,

fever and chills occurring frequently, and for the last week she has been confined to bed.

General Condition. Well nourished woman; tongue slightly coated, bowels regular, appetite poor. Micturition and defecation painless. For the past four weeks she has had a dry cough.

Examination of heart and lungs negative.

Temperature on admission 103° F., pulse 110.

Diagnosis. Large suppurating ovarian cyst.

Operation by Dr. Kelly, January 20, 1897. Cystectomy; part of cyst wall could not be removed.

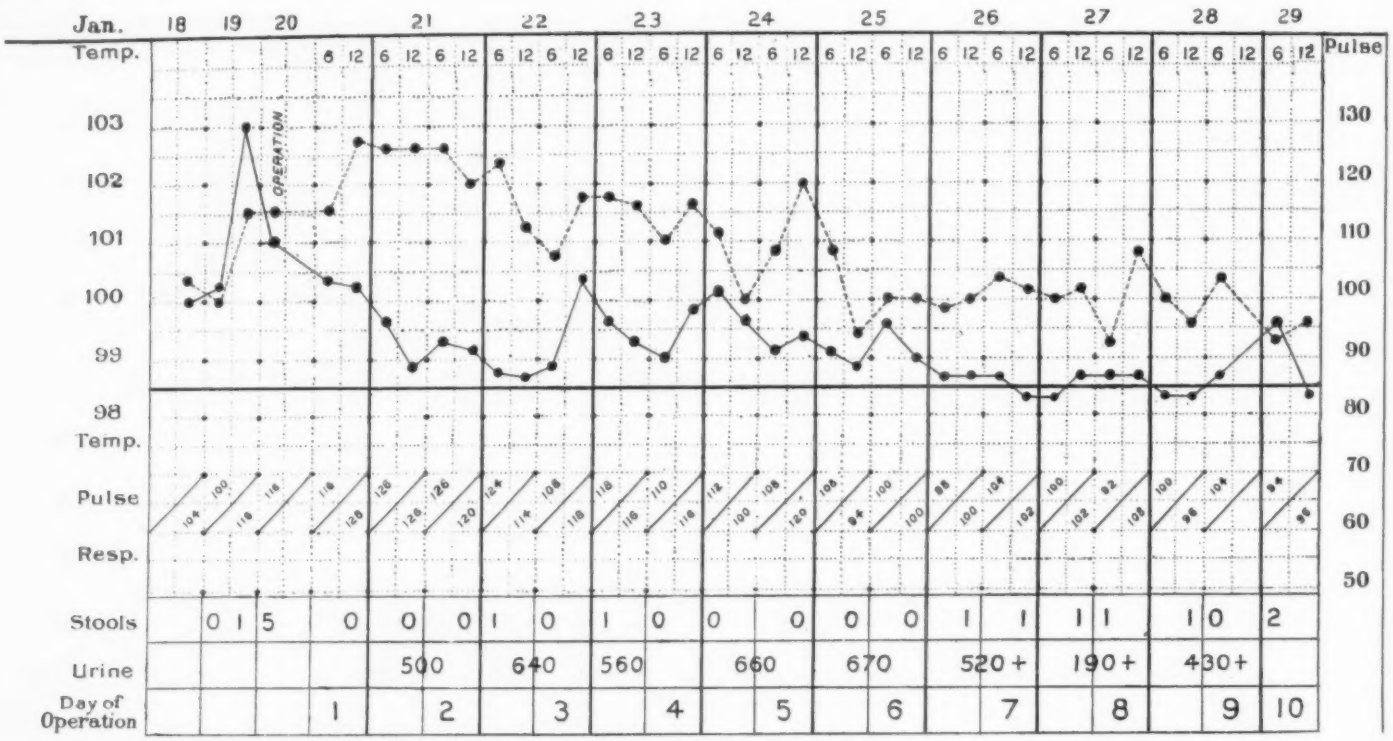
Complications. Extensive adhesions to mesentery, bowel and vermiform appendix. Adhesions to entire posterior pelvis, to omentum, to bladder, and to anterior abdominal wall. Patient greatly prostrated, pulse before operation 118, at close 144, during operation as high as 156.

Incision 14 cm. in length, exposing red mottled and whitish cyst wall, closely adherent to anterior abdominal wall over a surface 10 cm. above symphysis pubis. Omentum adherent to anterior face of cyst over an area 10x8 cm. Adhesions separated; free oozing from thickened omentum checked by catgut sutures, no omentum removed; just above this point there was a fringe of flat adhesions, binding cyst to intestines and skirting the whole upper border of tumor from left to right. Adhesions so dense that separation was impossible without great injury to intestines.

Tumor tapped, about 3000 cc. of thick, fetid, yellow pus evacuated; the puncture was then closed with sutures.

Ten minutes were spent in separating tumor from anterior abdominal wall, bladder and anterior pelvic wall.

Large Fallopian tube on left side was exposed up to a point



CASE I.

Plain line indicates temperature. Broken line indicates pulse.

where it was lost in the tumor. Adhesions to uterus, to pelvic floor on right side, and to part of left pelvic wall divided. On floor of pelvis a sac containing 300 cc. of thick brown pasty blood was evacuated. Ovarian vessels at left pelvic brim exposed by dissecting with knife, fingers and scissors, and ligated, the left cornu uteri was then tied off and cyst cut loose from top of left broad ligament.

In separating adhesions on pelvic floor a sac was ruptured, discharging a large quantity of fetid pus into the peritoneal cavity. This was quickly mopped out and the hole in the sac stuffed with gauze. Cyst cut loose, leaving a portion of abscess wall 5x8 cm. in dimensions on the pelvic floor. Gauze packed over this to protect it during the rest of the operation. Sac was peeled up and out of a dense bed of adhesions in the pelvis; it was then found that the adhesions, extending between the entire length of the mesentery and out onto the intestines, were too extensive for further separation. The outer layers of the cyst wall were slit 2 cm. from bowel on all sides and dissected out from beneath the mesentery, thus completing the enucleation and leaving behind a large cup-shaped dead space. Slight capillary oozing occurred from the portion of cyst wall remaining behind.

The portion left in the pelvis also required six or eight ligatures to control oozing. Small epithelial cyst on right side

punctured. Right ovary normal. Right tube adherent and closed.

Adhesions of right ovary to sac bled freely, requiring two sutures to control hemorrhage.

At completion of operation the abdomen was freely irrigated with many litres of salt solution, after which 700 cc. of salt solution were left in the abdomen. Abdomen closed with buried silkworm gut and subcutaneous catgut sutures.

Day of Operation. Patient's cough very troublesome, pulse 116, temperature 101° F. before operation. Returned from operating room at eleven o'clock, pulse 140, respiration 48, profuse perspiration over entire body. Twelve o'clock, pulse 132, respiration 46. One o'clock, pulse 129, respiration 44. Two o'clock, foot of bed elevated twenty inches. Five o'clock, pulse 116. Six o'clock, pulse 116, temperature 100.4° F. Twelve o'clock, temperature 100.3° F., pulse 128. Patient uncomfortable, but not suffering great pain.

Second Day. Six o'clock A. M., temperature 99.6° F., pulse 126. Patient slept in all about two hours, often rendered uncomfortable by cough and heavy perspiration. Bed lowered.

Twelve o'clock noon, temperature 98.8° F., pulse 126. Patient has been comfortable up to this time, cough more troublesome, she now feels nauseated. Six o'clock, patient has vomited four times during afternoon, but is now comfortable, temperature 99.4° F., pulse 120.

Twelve o'clock midnight, temperature 99.3° F., pulse 124. Cough troublesome.

Third Day. Patient slept most of the night, awakened at intervals by paroxysms of coughing. Bowels moved. Temperature 98.8° F., pulse 124.

Twelve o'clock noon, temperature 98.6° F., pulse 114. Six o'clock, temperature 98.8°, pulse 108. With exception of pain produced by coughing, patient has passed a comfortable day.

Twelve o'clock midnight, temperature 100.4° F., pulse 118.

Fourth Day. Six o'clock, temperature 99.6° F., pulse 118. Bowels well moved, patient comfortable. Twelve o'clock noon, temperature 99.4° F., pulse 116, patient very comfortable. Six o'clock, temperature 99° F., pulse 110.

From the fourth until the tenth day the patient made as perfect a recovery as the most uncomplicated cases of abdominal section. The abdominal dressings were removed on the tenth day; incision healed *per primam*, subcutaneous suture entirely absorbed. Cough ceased about this time. Patient sat up in bed on the sixteenth day, and was out of bed in a wheel chair on her nineteenth day, and was able to walk on her twenty-fifth day. She was discharged from the hospital on her thirty-fifth day, feeling perfectly well.

Case II.

In this case the operation was very difficult and attended by many complications. The peritoneum was injured extensively, pus escaped during the operation, the intestine was injured and required suture, free oozing occurred during the operation and persisted at its completion, and large denuded areas were left in the pelvis.

Gynecological No. 4892. A. E. T., widow, aged 34 years.

Complaint. Pain in the right inguinal region, pain in the rectum, and swelling of the abdomen at times.

Menstruation began at fourteen, flow scanty but regular, lasting two to three days; always painful before marriage, since then painless.

Marital History. Married 14 years ago; husband has been dead eight years. Four children, oldest 14 years, youngest 8 years of age. First labor instrumental, the others were easy. No miscarriages.

Family History. Negative.

Present Complaint. Three years ago she was confined to bed for three weeks with fever and chills and severe pain in the lower abdomen, which began in the right side and then shifted to the left. During the attack she had a constant discharge of thick tarry blood from the uterus. After the attack she was able to get up, but it soon recurred, and the abdomen became greatly distended and excessively painful. Ten days ago another attack began, which has not been so severe up to this time as the former ones. She complains of pain during defecation and micturition, backache and bearing-down pains. Temperature on admission 101° F., pulse 120.

Diagnosis. Pyosalpinx duplex; retroflexio uteri adherens; pelvi-peritonitis.

Operation. Enucleation of both ovaries and tubes.

Complications. Dense adhesions binding pus sacs to pelvic walls and rectum, close relation of abscess on right side with the iliac vessels, persistent oozing following operation, escape of pus during the operation into the abdominal cavity.

Incision 12 cm. through thin abdominal walls, intestines packed back into abdomen with gauze bolsters. Impossible to differentiate pelvic structures at first on account of the dense adhesions covering in and binding all of the organs together.

Sigmoid flexure released from mass to which it was bound by dense adhesions. Outer coat of the bowel torn for about 3 cm. during the separation, but was at once closed with interrupted catgut sutures.

The enucleation was then begun on the floor of the pelvis, working upward and freeing the ovary and tube which formed a sac containing 30 cc. of pus. These structures were then tied off and cut away from the pelvic wall.

The fundus of the uterus was then partially liberated from adhesions, but this was discontinued on account of the free bleeding and danger of tearing into the rectum.

A long fusiform mass on the right side extended along the iliac vessels, with which it was closely adherent, around in front of the bladder. The sac contained 60 cc. of thick white pus, which partly escaped during the operation.

After freeing all the adhesions, the round ligament and ovarian vessels were tied off and the mass excised.

Active oozing to the right of the fundus over the ureteral area, also posterior to the fundus. After controlling several of these points there was still free hemorrhage at a point on the pelvic floor to the left of the rectum and from another point on the under surface of the broad ligament. This oozing was sufficient to stain a sponge as fast as it could be applied. The abdomen was irrigated thoroughly with salt solution, after which the bladder and fundus and the fundus and parietal peritoneum were stitched together to control oozing and to cover the raw areas with peritoneum.

500 cc. of salt solution left in abdomen. Pulse at beginning of operation 92, at end 150. Time of operation one hour and a half.

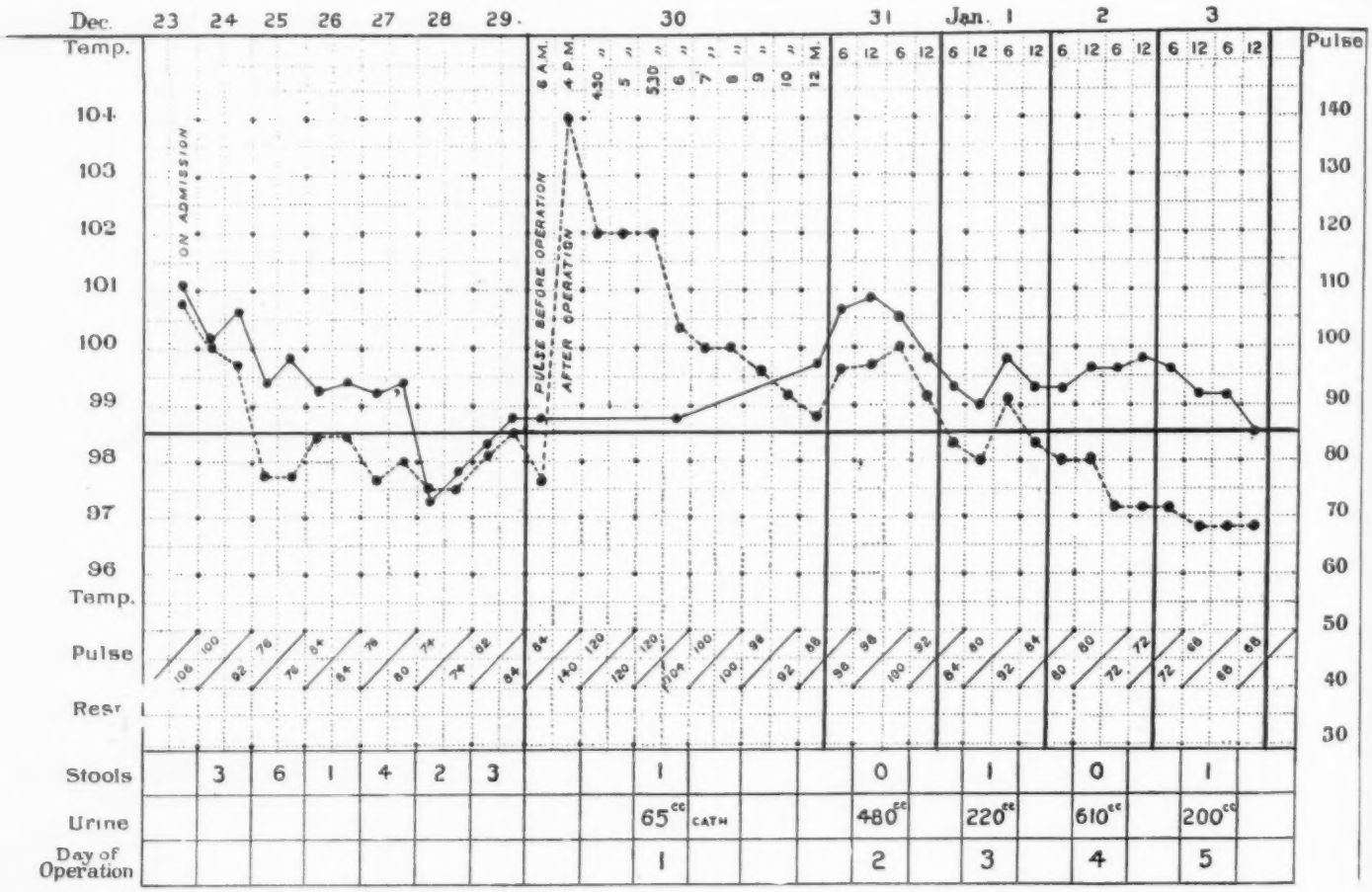
First Day. Patient returned to ward at four P. M., pulse 140. Bed elevated. Four thirty P. M., pulse 120, of good volume; six o'clock, pulse 104; seven o'clock, 100; nine o'clock, 96; twelve o'clock midnight, 88. Patient recovered quickly from ether without symptoms of shock.

Second Day. Six o'clock A. M., temperature 100° F., pulse 96. Patient complains of much pain. Twelve o'clock, pulse 92, temperature 100.8° F., patient sleeping quietly. Six o'clock P. M., temperature 100° F., pulse 100. Twelve o'clock midnight, temperature 99.8° F., pulse 92. Patient sleeping quietly.

Third Day. Six o'clock A. M., pulse 84, temperature 99.3° F. Bowels slightly moved. Condition remained about the same during day. Patient complained of some nausea, but did not vomit.

Fourth Day. Six o'clock A. M., pulse 80, temperature 99.4° F. Patient rested well, still slightly nauseated.

Fifth Day. Six o'clock A. M., temperature 99.6°, pulse 72. Bowels effectually moved, well formed stool. Patient passed a very comfortable day. From this time on the patient made a good recovery. On the tenth day after her operation the temperature rose to 100° F., and continued about this point until her seventeenth day, when it dropped to normal. At the time of her discharge she was feeling well.



CASE II.

Plain line indicates temperature. Broken line indicates pulse.

CASE III.

In this case there were dense adhesions binding a large suppurating ovarian cyst to the intestines and the abdominal wall. A suppurating fistulous track extended between the caput coli and one loculus of the cyst, requiring a number of silk sutures to repair the opening in the intestine left after the enucleation of the cyst. Pus escaped into the abdominal cavity, and large handfuls of clotted blood were ladled out of a large cavity in the pelvis. Pieces of the cyst wall and much debris remained behind at the completion of the operation.

There was considerable oozing and extensive traumatism produced by the separation of the wide-spread adhesions.

Pus from the cyst injected into a mouse killed it within twenty-four hours.

Notwithstanding all these complications the patient made a good recovery.

Gynecological No. 4928½. A. E. S., admitted January 9, 1897. Single, age 35 years.

Complaint. Increasing size of abdomen, severe constipation, feeling of obstruction in abdomen. Menstruation began at 15 years, recurring every 28 days, 4 to 5 days duration, normal.

Family History. Negative.

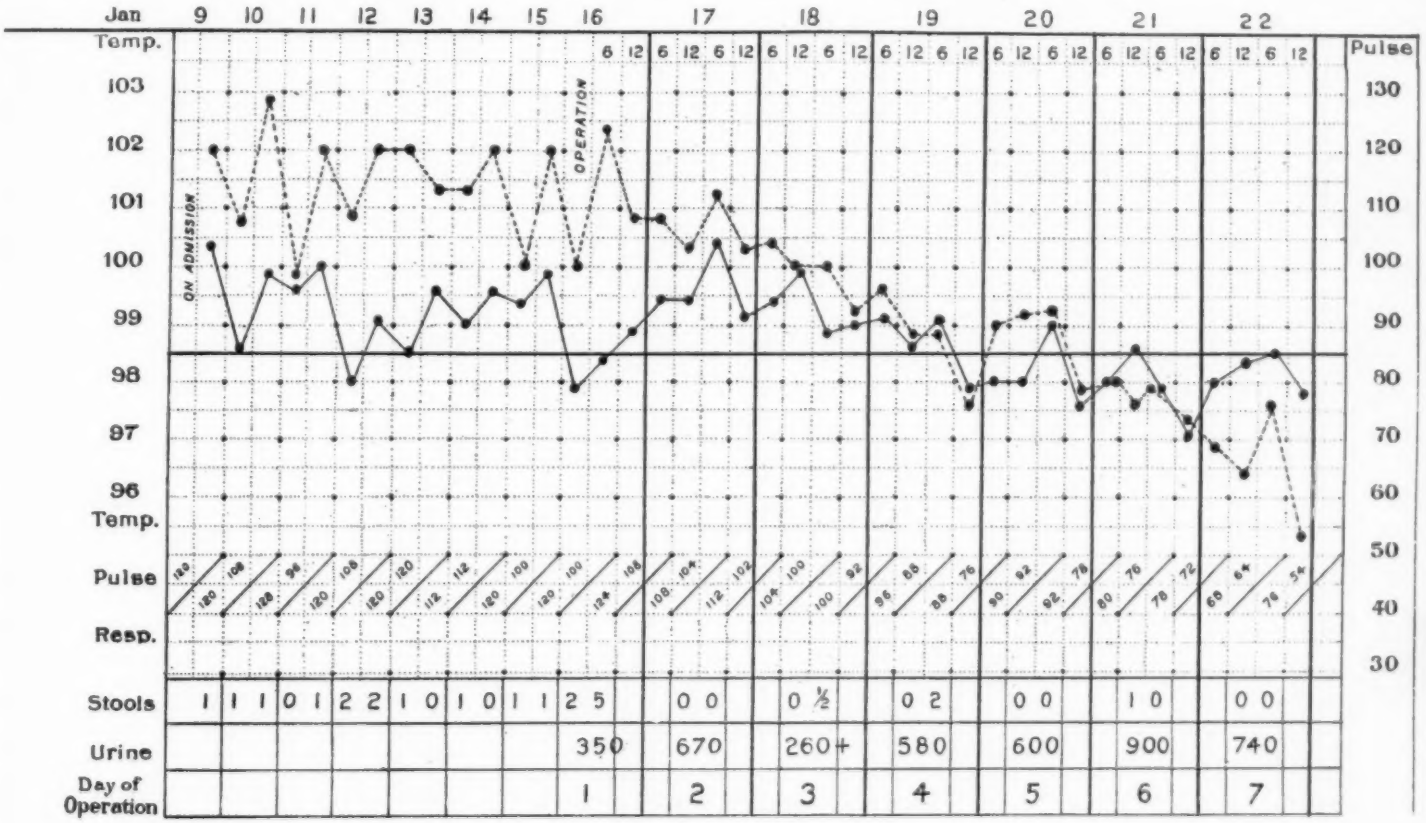
Present Illness. Patient was always strong and well until four years ago; at this time she suffered with indigestion, and was treated by her physician for displacement of the uterus. She had an attack of peritonitis in September, 1895, which confined her to bed four weeks. In October, 1896, she suffered with "chills and fever," which lasted eight weeks. During the attack she passed pus from the rectum, her abdomen was swollen and very tender to pressure. Enlargement of the abdomen persisted after this attack, and has lately been increasing rapidly.

She suffers from stricture of the rectum, which followed an operation for hemorrhoids performed in 1892.

Present Condition. Body emaciated, complexion pale, expression anxious. Appetite good. Micturition normal.

Examination of heart and lungs negative. Temperature on admission 100.5° F., pulse 120.

Diagnosis. Suppurating ovarian cyst.



CASE III.

Plain line indicates temperature. Broken line indicates pulse.

Operation by Dr. Kelly, January 16, 1897. Cystectomy.

Complications. Dense adhesions between cyst and intestine, fistulous opening between intestine and cyst. Pyogenic area over bladder and anterior abdominal wall.

Puncture and evacuation through the abdominal incision of 2800 cc. of fetid pus, part of which escaped into the abdominal cavity. During enucleation of cyst it tore, allowing 150 cc. of pus to escape. Large hematoma filling lower pelvis opened and handfuls of thick putty-like blood were ladled out, in all about 200 cc. Hydrosalpinx and adherent ovary on the right side released, but not removed.

Adhesions between caput coli and tumor released, exposing a fistulous track between the two 5 cm. in diameter. Appendix thickened and twice its normal size, adherent to a black ragged area 2x2 cm. It was not removed, as it showed no disease and the patient's condition was very critical.

On right side the tumor was adherent to the anterior abdominal wall over an irregular area 6x3 cm., running down to cornu uteri. This area was scraped free of pus and lymph and covered with peritoneum from side to side.

Ragged area on colon covered in by base of appendix, which was sutured over it with interrupted catgut ligatures. Silk sutures were used to close the opening in the colon. Abdominal cavity thoroughly irrigated. Salt solution infusion (500 cc.)

under breasts, 500 cc. of salt solution left in the abdominal cavity. Pulse before operation 132, after 150.

First Day. On returning from operating room the pulse was 136, having dropped 14 beats in twenty minutes. Foot of bed elevated. Five o'clock in the evening pulse 128. Nine o'clock, 120. Twelve o'clock, 108. Patient comfortable and complaining of little pain.

Second Day. Pulse 108, temperature 99.4° F. Patient complained of pain during the night, but slept three hours. Twelve o'clock noon, pulse 104, temperature 99.4° F. Six o'clock, pulse 104, temperature 100.4° F. Comfortable day. Foot of bed lowered.

Third Day. Passed an uncomfortable night. Pulse 104, temperature 90.4° F.

Afternoon, patient comfortable, pulse 100, temperature 99.8° F. Small liquid movement.

Fourth Day. Pulse 96, temperature 99° F. Considerable pain in abdomen.

Fifth Day. Temperature 98°, pulse 90. Patient had a comfortable night.

Sixth Day. Pulse 80, temperature 98° F.

Tenth Day. Convalescence has been uninterrupted. Dressings removed from abdomen, union of incision *per primam.*

Patient sat up on her 20th day.

Bacteriological Examination. Cover-glass preparations showed many cocci and bacilli. Two cc. of pus injected into a guinea-pig produced death from septicæmia in twenty-four hours. Cultures from pus at the time of operation and from autopsy of guinea-pig became contaminated, consequently it is impossible to make a definite statement as to the species of organisms present. The fact, however, that the cyst communicated with the intestine makes it practically certain that all of the intestinal bacteria were present in the pus.

REPORT OF FIVE CASES OF INFECTION BY THE BACILLUS AEROGENES CAPSULATUS (WELCH).

By Edward K. Dunham, M. D., *Professor of Bacteriology, Bellevue Hospital Medical College, New York.*

Within the past year the writer has had occasion to study five cases of infection in which he believes the bacillus aerogenes capsulatus, described by Welch and Nuttal, and Welch and Flexner, either caused or hastened death.

In all but one of these cases the bacillus was found in material taken from the tissues of the patient during life.

The first case died on the 11th of March, 1896.

The patient was a woman, aged 23 years, who was admitted to St. Vincent's Hospital, New York, on the 7th of that month, and then gave the following history:

Three days before her admission to the hospital she had noticed a swelling beneath the lower jaw on the left side of the neck. This swelling was the seat of throbbing pain.

From the time she first noticed this swelling she suffered increasing malaise, with chilliness, headache, loss of appetite, nausea, and pains in the back.

At the time of her admission she had difficulty in swallowing, stiffness of the jaw, and pain, with a sense of constriction, in the throat. The left submaxillary triangle was swollen, pale and œdematous. There was no fluctuation in the swelling, though it appeared somewhat softer near the angle of the jaw. On the left side of the lower jaw some of the teeth were carious. The floor of the mouth bulged upwards and was tense. The left tonsil was enlarged, but showed no signs of inflammation. Temperature 101.2°, respiration 22, pulse 98.

Hot applications were made to the neck, and a mouth-wash of listerine prescribed. She also received morphine subcutaneously, and phenacetine and quinine by mouth.

The next day, March 8th, the swelling had increased considerably in size, swallowing was very difficult, and the patient suffered somewhat from dyspnœa. The neck was stiff and gave great pain on the slightest motion. Articulation was also interfered with. An exploratory puncture of the swelling failed to reveal the presence of pus.

On the day following, March 9th, the pain in the neck was excruciating; swallowing was practically impossible; the voice was husky and the dyspnœa marked. The swelling was hard and rapidly increasing in size, the pulse rapid and weak, the facies drawn and anxious. The urine was found to contain "5 per cent." of albumen. On this day the patient began to show signs of delirium.

During the afternoon of the succeeding day, March 10th, œdema of the glottis set in and at one time completely arrested respiration, but by means of an O'Dwyer tube and artificial respiration for a few minutes the patient was restored and the tube could be removed. The patient gradually lapsed into a comatose condition.

On this day an incision was made into the swelling and a small quantity of fetid, "very virulent-looking" pus obtained.

The next morning, March 11th, there was no discharge from the wound, but emphysematous crackling was felt at the angle of the jaw. At 6 A. M. the patient was dead.

The pus obtained on the 10th of March reached the Carnegie Laboratory on the 11th, accompanied by a message stating that it came from an acutely septic case in which infection with the anthrax bacillus was suspected.

Cover-glass preparations of the very fluid pus revealed the presence of cocci and of bacilli of large size.

Agar tubes in four dilutions were prepared and placed in the incubator. Upon these two sorts of colonies developed, one of a yellow color and the other white. All of these colonies were made up of cocci, the bacilli in the pus having failed to grow. Subsequent cultures of the cocci served to identify them as the staphylococcus pyogenes aureus and albus.

On the same day that the pus was received bouillon tubes were inoculated from it and placed in a Novy jar, in an atmosphere of hydrogen, at 37° C. The next day the broth in these tubes was cloudy, and a hanging drop showed the presence of cocci and bacilli.

A guinea-pig was inoculated subcutaneously with 1 cc. of one

of these bouillon cultures and died during the following night. At the autopsy the subcutaneous tissue was œdematous and emphysematous, and the fluid contained both cocci and bacilli, the latter predominating.

An effort was now made to isolate the bacillus and obtain it in pure culture for the purpose of identifying it.

A minute quantity of the broth culture used to inoculate the guinea-pig was distributed over the surfaces of several oblique agar tubes, which were placed in hydrogen in the incubator. No colony entirely devoid of cocci was found in any of these tubes, but one in which the bacilli greatly predominated was used to inoculate four rather dry blood-serum tubes, and upon these pure colonies of the bacillus were obtained and utilized for further study.

The bacillus was a large straight rod, about 0.9μ in diameter, with rounded ends, usually occurring singly or in pairs, but occasionally forming threads made up of four or five individuals. It stained readily with methylene blue, gentian violet and carbol fuchsin, and was very retentive of the dye when stained by Gram's method, resisting the decolorizing solution of iodine for ten minutes or longer. No spores were observed in any of the cultures, except those upon blood serum, though occasionally old agar cultures contained involution forms with an intimation of beginning sporulation, but without spores demonstrable by differential staining. In the subcutaneous fluid of animals it possessed a capsule, but this was usually not observed in cultures on artificial media.

It formed a moderately thin, moist, gray growth upon agar, and sometimes produced bubbles of gas in the condensation water at the bottom of the tube or between the agar and the wall of the tube.

Bouillon was rendered cloudy, and usually a few bubbles formed at its surface, while a gray sediment appeared at the bottom. In hanging drops, to which air had access, no evidence of motility could be detected.

Milk was coagulated in 24 hours and rendered acid, with a production of gas.

In all the media the bacillus proved to be a strict anaerobe.

The bacillus grew well in bouillon to which 1 per cent of glucose had been added, and these cultures evolved a considerable amount of gas when incubated in an atmosphere deprived of oxygen by means of potassium pyrogallate.

In order to determine the nature of this gas, six fermentation tubes containing glucose bouillon (1 per cent of glucose) were inoculated with the bacillus, and, after 24 hours, the gas collected in a eudiometer over mercury. 28.6 cc. of gas were obtained. This was subjected to the action of caustic potash, and when no more shrinkage in volume took place, air was introduced and an electric spark passed through the mixture. This was repeated until no more shrinkage in the bulk of the mixture resulted after the passage of a spark.

In this way the following approximate composition of the gas was determined:

Hydrogen	64.3 per cent.
CO_2	27.6
Nitrogen (?)	8.1*
	100.00 per cent.

On the 22d of March, *i. e.* eleven days after the pus was received at the laboratory, a guinea-pig was inoculated, subcutaneously, with a pure 24 hour culture of the bacillus in bouillon, one cubic centimeter being injected. The animal was found dead the next morning. The hair over the body was loosened so that it could be readily plucked from the skin, leaving it smooth and clean. The subcutaneous tissue was œdematous, and so friable and filled with gas that the skin could be reflected from the abdominal wall without dissection. The gas burnt with a pale blue flame. The organs were of a dull gray color and very friable. The subcutaneous fluid contained great numbers of the bacilli surrounded by capsules, and apparently no other micro-organisms.

On April 3d, 23 days after obtaining the material from the hospital, another guinea-pig was inoculated, by means of a platinum needle, with a very small amount of a three-day culture of the bacillus on agar. The animal became very ill on the second day after inoculation and it was thought at that time that he would surely die in the following night, but he recovered after two days and remained well.

When injected into the blood of a rabbit, which was then killed after the lapse of a few minutes, the bacillus caused enormous swelling of the body of the animal within 20 hours, and the liver, kidney and spleen, as well as the subcutaneous tissue, were the seat of a very marked emphysema. The skin was rendered so tense by the accumulation of gas that it seemed on the point of rupturing.

The foregoing characters of the bacillus under study appear to identify it with the bacillus aerogenes capsulatus of Welch, the only point of difference being the spore-formation which was observed in cultures on blood serum. As the authors mentioned do not describe cultures on this medium, this spore-formation cannot be regarded as evidence against the identity of the two bacteria.†

A number of observations were made upon the resistance of these spores, and it was found that when taken from the condensation water of a blood-serum tube they could endure a temperature of 94° C. for one minute, but that an exposure of 5 seconds to the temperature of boiling water (99.5° C. at the time the observations were made) killed them. After being dried upon threads for 5 months and then immersed in water, they survived a temperature of 99° C. when subjected to it for one minute.‡

The vegetative form of the bacillus appeared to be killed by a temperature of 55° C. within one minute.

Ten months of desiccation and exposure to the air failed to kill the spores, which, at the end of that time, grew readily

*The composition of the residual gas in the eudiometer was not determined, but it did not contain CO_2, for no diminution occurred when a fresh piece of caustic potash was introduced. This fact proves the absence of marsh gas or of any other hydrocarbon.

†In a letter to the writer, dated February 19th, 1897, Dr. Welch states that the bacillus aerogenes capsulatus in his possession produced spores when cultivated on Loeffler's blood serum. This observation tends to still further establish the identity of the bacillus isolated by the writer.

‡The author has observed that the spores of bacillus subtilis are much more easily killed by moist heat when freshly formed than after a lapse of time and drying.

when placed in broth at the body temperature under anaerobic conditions, and those cultures caused the same extensive production of gas when injected into the blood of a rabbit which was soon thereafter killed, as did the earlier cultures obtained from the original material.

The spores stain readily in hot solutions of fuchsin in anilin water, and are not decolorized by a moderate exposure to the action of a 3 per cent. solution of hydrochloric acid in absolute alcohol.

They have an oval shape and are usually situated near the middle of the bacilli in which they have been formed, their long axes coinciding with those of the bacilli. Their short diameter exceeds the diameter of the bacilli, so that the latter appear swollen at the points where the spores are situated.

The cultures containing the spores frequently contain involution forms of the bacilli and threads of the latter, which stain but faintly with methylene blue, and appear more attenuated than the individuals in fresh cultures on other media.

A partial autopsy of this first case of infection was made on the day following the death of the patient by my assistant, Dr. Harlow Brooks, from whose notes I take the following data:

General nutrition excellent. Rigor mortis present. There was extensive post-mortem discoloration about the neck on the left side, and the tissues in this region were the seat of marked emphysema.

The incisions in the neck made before the death of the patient were opened and a focus of suppuration was found, which apparently arose from the left tonsil. The walls of this abscess cavity were not well defined, but appeared necrotic, and this condition extended far into the fasciæ of the neck.

The liver, kidneys and spleen were examined, but did not appear emphysematous. Microscopical examination of bits of those organs failed to reveal the bacillus.

Sections from the organs of the rabbit into the veins of which the bacillus was injected, when stained by Gram's method, revealed the presence of the bacillus in great numbers in the blood-vessels. (See "I," temperature chart.)

The second case of infection occurred in a boy, seven years of age, who fell over a banister from the fourth to the ground floor of a house and sustained a compound comminuted fracture of the right humerus. This accident took place at 3 p. m. on the 19th of September, 1896.

After being under the care of a physician not connected with the hospital for a couple of hours, the patient was admitted to the Gouverneur Hospital at 6 p. m., in a semi-conscious and delirious condition. He had a lacerated wound of the forehead as well as a fracture of the humerus. The arm was very dirty and its tissues much contused. The wounds were treated antiseptically and the patient sent to the ward in a poor condition.

At 8 p. m. his temperature was 100°, respiration 44, pulse 130 and very feeble.

On the 20th he was delirious throughout the day.

On the 21st the dressings were removed and the arm and shoulder found to be much swollen, the skin over them tense and of a greenish bronze color, the discoloration extending over the pectoral region. There was no sign of emphysema noted at this time.

Free incisions were made and the subcutaneous tissues found in a necrotic condition. The wounds were washed with mercuric chloride and drained.

On September 22d the patient was still delirious, very weak, with a fluttering pulse. The dressings were again removed and fresh incisions made in the arm. The œdema had extended well into the pectoral region and down to the elbow, and at this time, I believe, some emphysema of the tissue was noticed. There was, however, no discharge from the wounds, owing to the prostration of the patient.

At 3 p. m. the patient died, just three days after the accident which resulted in the fracture of the humerus.

Some of the discharge from the incisions made on the 21st of September was collected in a sterilized test-tube and sent to the Carnegie Laboratory. It was delayed in transit and had an offensive odor when received. Cover-glass preparations showed it to contain cocci and a large bacillus, with rounded ends, positive to Gram's stain, and, in some fields, surrounded by a capsule.

Slant tubes of agar were prepared and placed in the incubator; one-half in a Novy jar with pyrogallate of potassium, the other half with access of air.

After 48 hours the aerobic cultures showed only colonies of cocci, while the anaerobic cultures contained colonies in which both cocci and bacilli had developed. The latter tubes gave evidence of gas production, the agar being raised from the bottoms of the tubes. These colonies, though not pure, were used for the preparation of bouillon cultures grown under anaerobic conditions, and, after 24 hours, they were cloudy and covered with a froth, due to the evolution of gas. In hanging drops both cocci and bacilli were found, the latter in greater number. One cubic centimeter of one of these cultures was injected under the skin of a guinea-pig, and in a few hours the animal showed signs of illness. Its fur was ruffled, the animal drew itself together and avoided the light. But it recovered, and after three days appeared to be quite well again.

A few drops of the same culture were introduced into an ear-vein of a rabbit and five minutes later the animal killed. The next morning its body was greatly distended by universal emphysema of the subcutaneous tissues. Puncture of the skin permitted the escape of a gas which burned with a pale blue flame.

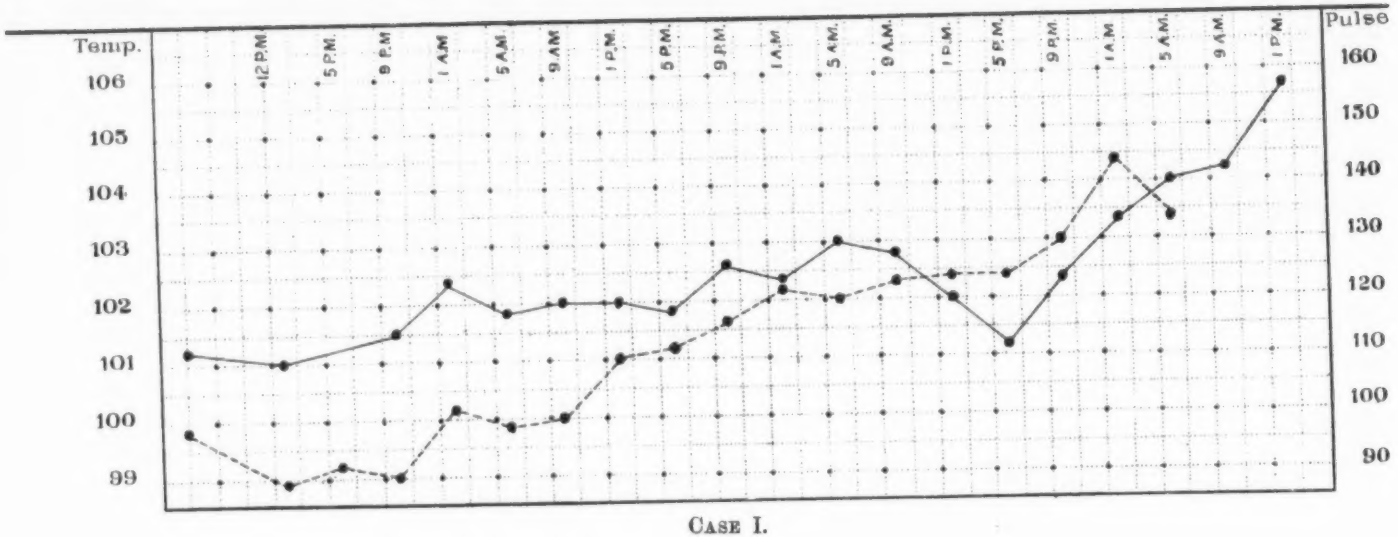
On autopsy the abdominal cavity was found to contain much gas, and the liver, kidneys, spleen, and the mucous membranes of the digestive tract and bladder were emphysematous.

Cover-glass preparations from the viscera and subcutaneous fluid demonstrated the presence of the bacillus, accompanied by a few cocci.

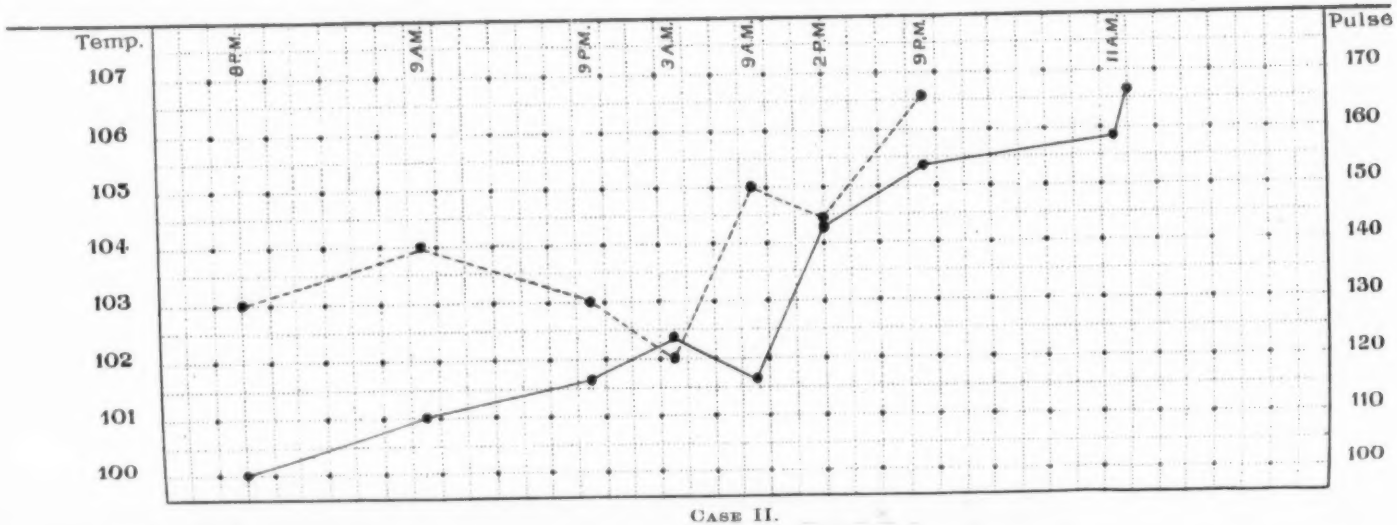
Agar cultures prepared from the organs of this rabbit formed the basis of future pure cultures, which served to identify this bacillus with that found in the first case. No spores were found in any of the cultures, but, unfortunately, the bacillus was not grown on blood serum.

No autopsy was performed on this second case of infection. (See "II," temperature chart.)

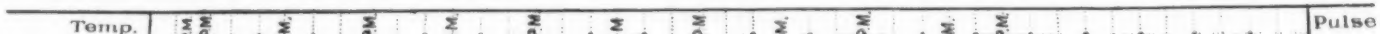
The third case of infection was a man, æt. 33, of alcoholic habits, who had suffered from urethritis on two occasions the



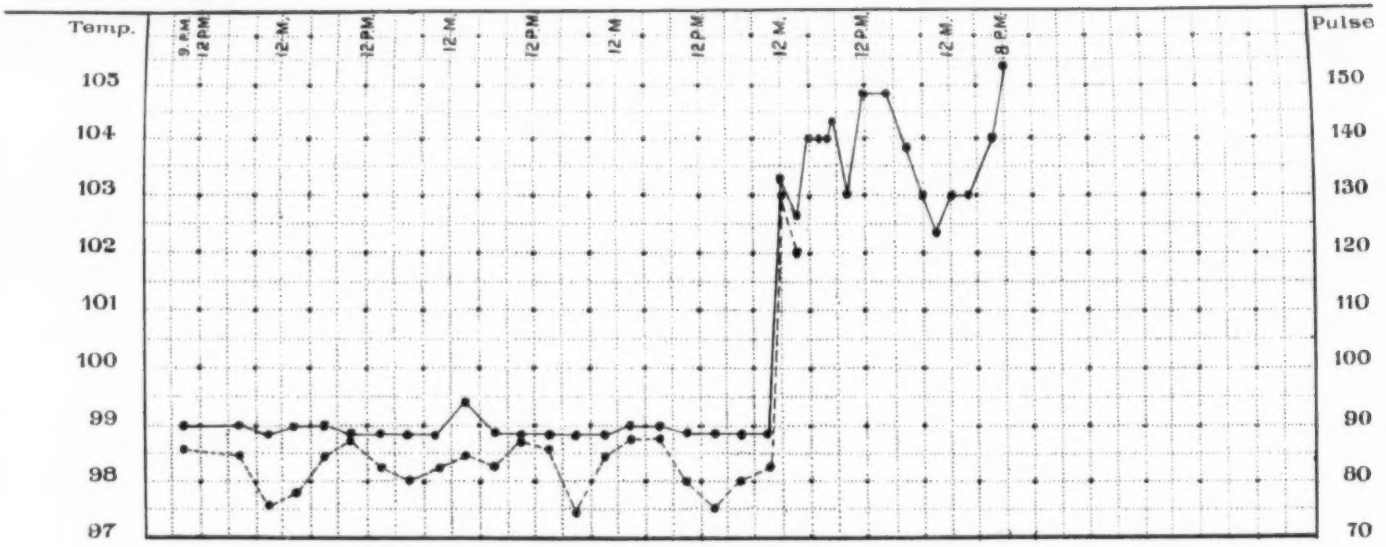
CASE I.



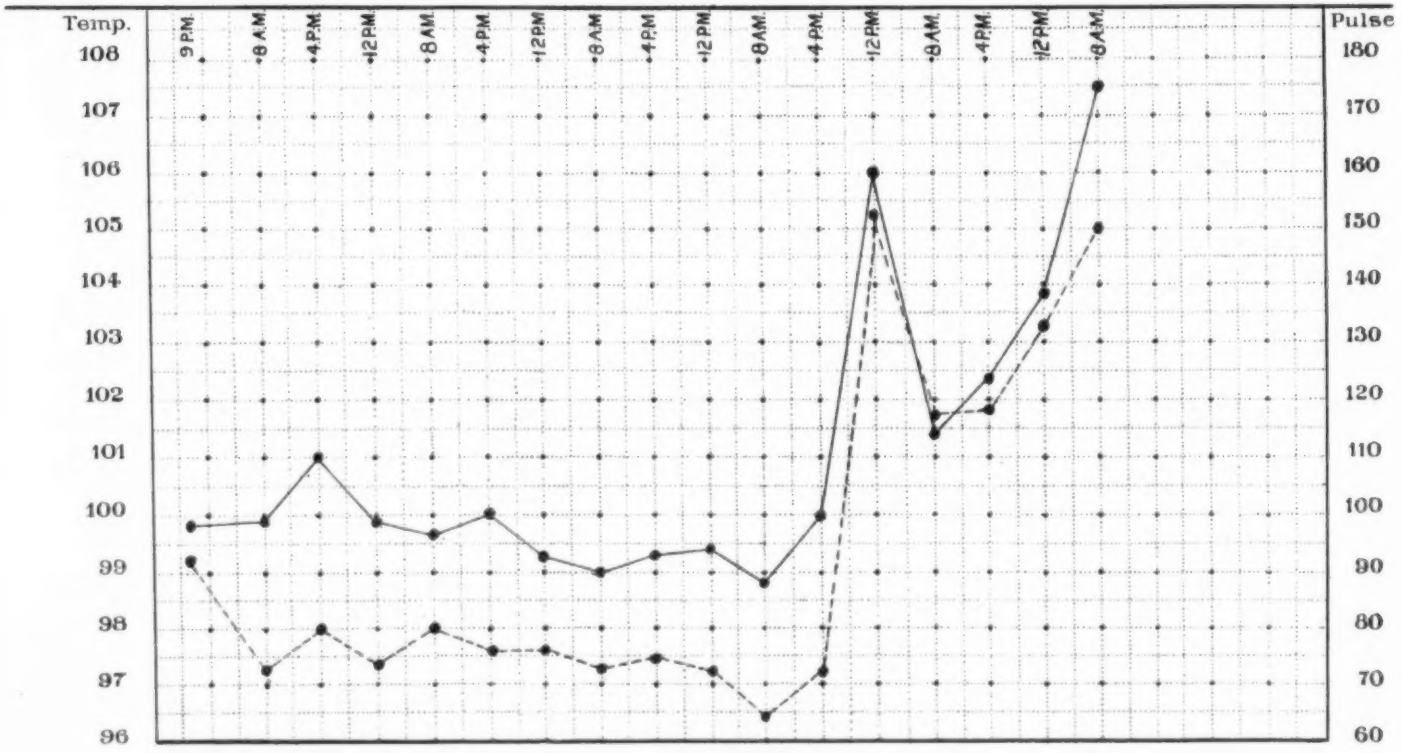
CASE II.



CASE II.



CASE III.



CASE IV.

Plain line indicates temperature. Broken line indicates pulse.

last time three years before he presented himself for final treatment at Bellevue Hospital.

When he was admitted to the hospital, on November 6, 1896, he had difficulty in voiding his urine, owing to a stricture of the urethra which could not be passed by instruments.

On December 5th, at 3.30 p. m., external urethrotomy was performed, and the patient did well until 2.30 p. m. on December 8th, when a sound was passed.

Twenty-one hours after this procedure a chill ensued, which was followed by severe pains in the joints and back, and from that time the patient rapidly grew worse and died on the 10th of December at 8 p. m.

At 9 p. m. on the day preceding death, an area of subcutaneous emphysema appeared over the front of the right thigh, and others over both shoulders. These areas increased rapidly in size up to the time of death and afterwards.

The following notes on the bacteriological examinations of material from this case and of the autopsy are kindly furnished me by my assistant, Dr. F. M. Jeffries, who conducted them. At 4 p. m. on December 10th, *i. e.* 4 hours before the death of the patient, three agar tubes were inoculated from the subcutaneous tissue in the emphysematous area on the thigh. These, although placed under anaerobic conditions, failed to develop, probably because of excessive acidity of the agar.

At the autopsy made 18 hours after death, cultures on agar and in bouillon were made from the heart, lungs, liver, brain, and the emphysematous area on the thigh. These cultures were incubated under anaerobic conditions in Novy jars with pyrogallate of potassium.

After 24 hours the cultures from all these sources had developed, with evolution of gas. They all consisted of bacilli resembling the bacillus aerogenes capsulatus. They were not motile and stained well by Gram's method. All the cultures contained only this one bacillus, without admixture of other bacteria.

Intravenous injection of a bouillon culture in a rabbit which was killed five minutes later, resulted in the post-mortem changes already noted in the other cases just described.

The bacillus produced spores when cultivated on blood serum.

The autopsy on this case was performed on December 11th, 1896, at 2 p. m.

The general nutrition was good.

Subcutaneous emphysema was noted, extending over the whole body, with a greenish discoloration over the thorax, right thigh and posterior surface of the body; most marked over the penis, scrotum and anus. Puncture of the emphysematous area permitted the escape of gas, which burned with a faint blue flame.

The connective tissue under the skin of the thorax and abdomen was soft, pulpy and emphysematous. There were emphysematous areas on the pleuræ and pericardium. There was general emphysema of the lungs. The cavities of the heart were distended, their walls soft and œdematous, and the blood they contained dark and fluid.

The liver was of a dark chocolate color, soft and the seat of emphysema.

The spleen was dark plum-colored, extremely friable and emphysematous.

The kidneys were enlarged, showed subcapsular emphysema, and were plum-colored.

The mucous membrane of the bladder was extremely emphysematous.

The brain showed submeningeal emphysema, its substance was soft, the ventricles normal.

Microscopical examination of smears from the organs revealed the presence of large encapsulated bacilli resembling those found in the cultures. (See "III," temperature chart.)

The fourth case was a man, 23 years of age, who was admitted to the J. Hood Wright Memorial Hospital on the 6th of January, 1897.

Four years ago he had gonorrhœa, which persisted for eight months, and three years ago he had another attack of the same trouble which lasted three months. Neither of these attacks was accompanied by symptoms pointing to inflammation of the bladder or testes.

Two years ago, *i. e.* about one year after the beginning of the second attack of gonorrhœa, he felt pain on urination and noticed that the stream of urine was diminished in size. Shortly after this he had retention of urine, and was catheterized with some difficulty, and the urethral stricture then gradually dilated with sounds, the treatment lasting for two months. Since that time he had omitted all treatment.

At the time of his admission to the hospital the patient complained of pain on micturition, but there was no discharge from the urethra or increased frequency of urination. The urine was acid; sp. gr. 1029; no albumen or sugar.

A urethral examination gave the following results:

No. 23 (French) bougie à boulé passed the meatus, but was stopped just beyond the urethral orifice.

No. 30 entered the urethra for a distance of 2¾ inches.

No. 25 slipped past a constriction at 2¾ inches, but was arrested at about 6¼ inches.

No. 30 and No. 15 sounds met with an obstruction at the same point.

No. 4 and No. 2 bougies also failed to pass that point, as did also a filiform bougie. Even a bunch of filiform bougies failed to demonstrate a passage, although, subsequently, after etherization in preparation for the operation, a filiform bougie was successfully passed.

External urethrotomy was performed on January 9th, at 4.40 p. m., and a perineal drainage tube was left in the bladder, held in place by a silk ligature passing through the skin. The bladder and urethra were irrigated with saline solution and an aseptic dressing applied to the perineal wound. The urethra admitted a No. 34 (French) sound.

The patient was returned to the ward at 5.20 p. m., and a conducting tube, with its distal end immersed in a 2½ per cent. solution of carbolic acid, was attached to the perineal drainage tube.

At 6.30 p. m. the patient vomited some blood. The dressings were found to be saturated with blood and were renewed. A slight oozing of blood from a wound in the bulb of the urethra was noticed. This had ceased at 9 p. m., and the patient then felt comfortable.

At 10.30 the bladder was again irrigated.

On January 10th the patient felt well and the bladder was draining nicely.

At 1.30 the urethra and bladder were irrigated with a warm saturated solution of boric acid. The anterior urethra contained some dark fluid blood which was washed away, and the perineal wound then dressed.

On the 11th and 12th of January the patient was doing well and the bladder was simply washed out.

The patient complained of some pain in the penis on the 13th, and at 2.30 p. m. sounds were passed down to the stricture, and gradually increasing in size up to No. 32 (French). The perineal drainage tube was then removed and a No. 32 sound passed through the entire urethra into the bladder, without difficulty. The perineal wound appeared healthy, and there was no discharge from the urethra except a small amount of blood which followed the manipulations. The anterior urethra was irrigated with saline solution and the perineal wound dressed. The patient felt somewhat chilly and received half an ounce of whiskey.

At 9.30, seven hours after the sounds were passed, the patient had a severe chill, lasting half an hour.

At 2.30 a. m., January 14th, a slight bleeding took place from the urethra.

At 8 a. m. pain in the left shoulder was complained of.

At 11 a. m. a catheter was introduced through the perineal wound and about 3 ounces of bloody fluid having a foul odor evacuated from the bladder, which was then irrigated with saline solution. The bladder and anterior urethra were again washed out at 5 p. m., this time with a solution of permanganate of potash, $\frac{1}{2500}$. The wound was dressed at this time and looked clean. The patient complained of pain on pressure in the left buttock.

At 9 p. m. the pains in the shoulder and buttock had become severe, and at 11 p. m. these parts were found to crepitate on manipulation. The skin over these areas was not reddened and the parts were only slightly swollen. The area on the left buttock did not extend to the perineum, but was limited to the region about the trochanter and the external aspect of the ilium. The area at the shoulder was confined to the region overlying the left scapula.

On January 15th, at 4 a. m., the emphysematous areas had become somewhat larger and more swollen, firmer to the touch, and a little darkened in color. The patient, who was conscious, had an anxious expression and presented an extremely septic appearance,

At 7 a. m. the body was jaundiced, except over the emphysematous areas. Of these, that on the buttock looked much darker than before and was irregularly mottled with purple spots.

At 8.15 a. m. an incision, two inches in length, was made into the emphysematous area on the left buttock. A considerable amount of gas escaped through the wound, and a slight oozing of sanguineous fluid took place, but there was no sign of pus. Material for culture and bits of tissue for microscopical examination were taken from the walls of the incision.

At 9.30 the patient was still conscious, but died at 10.10 a. m., forty-five hours after the sounds were passed on the 13th of January.

Dr. Brooks performed the autopsy on this case, and the following account is taken from his notes :

The autopsy was made 5 hours after death, while the body was still warm.

Rigor mortis was marked; the general nutrition good.

Post-mortem discoloration was extreme from the pelvis up, and there was emphysematous crepitation over the abdomen, especially in the suprapubic region; over the back, the buttocks, and the thigh, leg, and dorsum of the foot on the left side; also, though in less degree, on the right side.

Puncture of the emphysematous areas permitted the escape of a gas which burned with a blue flame.

The abdominal wall was greatly distended, and when an incision was made the inflated intestines protruded.

The liver was of a light clay color and crepitated under the fingers. Its tissues were very friable, and filled with minute vesicles containing gas. The cut surface appeared œdematous.

The spleen was enlarged, of a dark purple color, and very friable.

The kidneys were enlarged; their capsules adherent.

The lungs were somewhat œdematous.

The cavities of the heart were distended on both sides by fluid blood which contained bubbles of gas.

The autopsy was necessarily both hurried and incomplete, as the relatives of the patient refused to have any of the organs removed from the body.

During the autopsy agar tubes were inoculated by Dr. Brooks from the blood in the left auricle and from the tissues of the liver, spleen and kidney. A bouillon culture was also made from the blood. These cultures were then incubated in a Novy jar with pyrogallate of potassium, and after 14 hours developed pure cultures of a bacillus identical with those found in the preceding cases.

When grown upon blood serum these bacilli developed spores identical in character with those produced by the bacillus isolated from the pus from the first case.

Cover-glass preparations made at the autopsy from the same organs from which cultures were taken showed the presence of the bacillus.

One cubic centimeter of the bouillon culture from the blood was used to inoculate a guinea-pig subcutaneously. Within three hours the animal was manifestly ill, appearing to feel cold and to wish to avoid the light. It died within 20 hours, and at the autopsy presented marked emphysema of the areolar tissues and organs.

A rabbit was also inoculated, intravenously, with the bouillon culture, killed and put in a moderately warm place. The next day it showed the emphysematous condition of the subcutaneous tissues and internal organs which has already been described in connection with the other cases.

The material removed when the incisions were made into the emphysematous area on the buttock at 4 p. m. on the day of the death of the patient was used to inoculate agar tubes, part of which were cultivated with access of air, the rest under anaerobic conditions. Those exposed to the air showed no growth. Those grown with exclusion of oxygen contained

a growth of a non-motile bacillus, positive to Gram, and morphologically resembling the bacillus aerogenes capsulatus. These cultures were lost and no further observations could be made, but as considerable work on this bacillus was being done at the time, no doubt exists as to the identity of the bacillus.

About 2½ hours after the death of the patient a sterile cotton swab was introduced into the urethra, and the moisture thus obtained used for the preparation of cultures.

Two bacilli developed in these cultures, and as they were both at least facultative anaerobes, efforts to separate that which proved to be a strict anaerobe were unsuccessful. One was smaller than the other and grew when air was admitted to the cultures. The other was morphologically identical with the bacillus aerogenes and did not grow in cultures exposed to the air. The smaller bacillus was thought to be the bacillus coli communis. A mixed bouillon culture of the two bacilli was injected into one of the veins of a rabbit's ear, and 15 minutes later the animal was killed. The next day the body was bloated and the large bacillus was found in the subcutaneous fluids, which were both emphysematous and œdematous.

As a check upon this experiment a second rabbit was inoculated with a pure culture of the colon bacillus in the same manner and at about the same time as the first rabbit. The next day there were no signs of emphysema in its body. (See "IV," temperature chart)

The fifth case occurred in the private practice of a New York physician, who has kindly furnished the writer with the following facts concerning the history of the case.

The patient was a man, 73 years of age. His general condition was good, there being no organic trouble except some hypertrophy of the prostate.

On January 17th, 1897, the patient complained of pain and uneasiness in the perineum. This was traced to enlargement and tenderness of the prostate and of the tissues near the rectum in the median line.

The next day the pain was more severe, and a diagnosis of prostatitis was made. The pain was alleviated by means of opium and belladonna suppositories, and by the 20th of January the patient felt able to be about again.

That night, because of difficulty in voiding his urine, the patient passed a hard rubber catheter and drew some blood.

On the 21st, pain in the right ischio-rectal fossa was noticed, and the tissues at the site of the pain were found to be firmer than normal.

On the 22nd the pain in the right buttock was more severe. The patient was in bed, felt prostrated, and had a dry tongue and some fever. Temperature about 101°.

On the 23rd the general condition was about the same as on the day before. Temperature 102°. There was increased hardness of the tissues of the right buttock, and the pain there was very great.

On the 24th there was evidence of a pointing abscess in the buttock, in which the pain was excessive.

At midnight a sudden rupturing of this abscess into the neighboring tissues was felt, and immediately the scrotum became enlarged and the pain in the buttock was relieved.

The next morning, January 25th, the attending physician found the scrotum emphysematous, with spots of gangrene upon it. Temperature 103°.

Later in the day the perineum was tense and distended, red and tympanitic. The scrotum was the size of a child's head (8 to 10 inches in diameter), dark in color, in places almost black, and cold to the touch. The skin of the penis was ballooned with gas and dark.

Very extensive incisions were made to the right of the raphé, from the penis to the tuberosity of the ischium. No pus was found, except at one point near the anus, where there was a cavity containing a dirty grayish-yellow pus of offensive odor.

The areolar tissue of the scrotum and penis were of an inky blackness and emphysematous, but contained no pus. A slight œdematous condition prevailed in the deeper structures.

The tissues were irrigated with mercuric chloride and an iodoform dressing applied.

On the following day, January 26th, the emphysema had extended over the pubes and the hypogastric region, the skin being raised about half an inch. The color of the skin over this area was either normal or had a pinkish blush.

Two free incisions were made to evacuate the gas, and it was discovered that the subcutaneous areolar tissues were blackened. No pus was present.

A portion of this black slough was removed with sterile instruments and put in a sterilized bottle for examination.

On the 27th the emphysema and necrotic area had extended upwards to the sternum, and laterally to the shoulder-blades, and fresh incisions were made. A single focus of pus found above the navel.

In all the places where prior incisions had been made the sloughing had extended so as to include the skin, but without the formation of pus.

The patient lapsed into a low typhoid condition, then into coma, and died on the 31st of January.

Cover-glass preparations of the material removed from this patient on January 26th were examined on that day at the Carnegie Laboratory, and showed the presence of three species of bacteria: 1, a large bacillus, resembling the bacillus aerogenes capsulatus; 2, a more slender bacillus; 3, streptococci.

The slender bacillus was identified as the bacillus coli communis, and when obtained in pure culture, produced no emphysema in the body of a rabbit killed shortly after the injection of the culture into a vein of the ear.

Experience with the mixed cultures, obtained from the cotton swab used to collect material from the urethra in the fourth case, had shown the difficulty of separating the bacillus aerogenes capsulatus from the bacillus coli communis. Without waiting, therefore, to obtain pure cultures of the large bacillus found in this case, a mixed bouillon culture of the two bacilli was injected, intravenously, into a rabbit, which was shortly afterwards killed. The usual post-mortem emphysema was produced within a few hours, and from the subcutaneous fluids pure cultures of the bacillus aerogenes capsulatus were finally obtained. These, unfortunately, died out in future cultures, owing, it is thought, to the reaction of the agar which was employed as a culture medium and which was found to be strongly acid.

No accurate temperature chart could be obtained in this case, and there was no autopsy.

The foregoing cases appear of interest as showing that the bacillus aerogenes capsulatus is sometimes capable of rapid development within the human body, during life, and of causing an acute and speedily fatal infection.

They serve also to show that the bacillus is of pretty wide distribution; for within eleven months these five cases have come under the observation of a single individual and were, notwithstanding, wholly unconnected with each other, occurring as they did in various parts of the city of New York and coming under the care of different physicians.

The mode of infection was not the same in all of the cases. But it is a striking circumstance that in three of the cases the infection started near the perineum after injury to the urethra, and in two of these the bacillus aerogenes capsulatus was associated, as far as the wound was concerned, with the bacillus coli communis.

In the case in which the site of infection was the wound of a compound fracture of the humerus, the history states that the wound was covered with dirt. This fact naturally leads to the suspicion that the bacillus aerogenes capsulatus, like so many of the anaerobic bacteria with which we are familiar, may occur in the soil; and the occasional production of spores, noted in the account of the first case and also observed in similar cultures from the fourth case, might readily explain the persistent vitality of the species under conditions which would otherwise be fatal to it.

From the soil to the intestinal tract of man would be a simple route by which the bacillus might gain access to the human body and find conditions not unfavorable to its development and, perhaps, spore-formation.

If the bacillus once gained access to the intestinal tract its presence in the perineal region could occasion no surprise. And if, through the wounded urethra, or some other lesion, it once reached the subcutaneous tissues and possessed sufficient virulence, the gangrenous process illustrated by these cases would ensue as a matter of course.

OBSERVATIONS TO DETERMINE THE MOTILITY OF THE BACILLUS AEROGENES CAPSULATUS UNDER ANAEROBIC CONDITIONS.

By E. K. Dunham, M. D.

Bouillon cultures of the bacillus were studied in flattened capillary tubes from which the oxygen of the air had been absorbed by means of pyrogallate of potassium. Although these cultures were examined at intervals varying from 15 minutes to 24 hours, at no time could any evidence of motility on the part of the bacilli be detected.

The details of the experiment were as follows:

The cultures were obtained by putting threads, containing spores of the bacillus, which had been kept in a dry state for 11 months, into tubes containing sterile bouillon. Three such tubes were prepared, and after incubation in a bottle containing pyrogallate of potassium, they all showed an abundant growth of the bacillus within 24 hours. These cultures proved to be pure. One cubic centimeter of one of these cultures was then mixed with about 2 cc. of fresh sterile bouillon, in order that the bacilli present might have a good supply of nourishment, and this mixture used for the observations on motility.

The capillary tubes were prepared by heating a piece of glass tubing, about 8 inches long and with a bore measuring about ½ of an inch, strongly in the middle, then bringing the two halves parallel to each other and separating them about two inches (Fig. 1). In this way a U-shaped tube with a flatted bend was obtained. The limbs of this tube were then bent at right angles, so that their axes were in the same straight line. The ends of the tube were plugged with cotton and the tube sterilized by dry heat (Fig. 2).

A few moments before use, the middle of the flattened portion of the tube was heated until quite soft, and then rapidly drawn out to form a capillary tube. This was then broken in the centre and the end immersed in the bouillon culture. A portion of the culture quickly filled the capillary part of the tube for a distance of from 2 to 3 inches. The end of the capillary tube was then sealed in the edge of the flame of a Bunsen burner. Enough pyrogallic acid to closely fill about 1 inch of the tube was then introduced into its large end, this was moistened with a 50 per cent. solution of caustic potash in water, and then the end of the tube was closed by means of a piece of rubber tubing plugged at the other end with a bit of glass rod (Fig. 3).

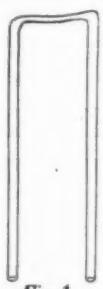


Fig. 1.

Fig. 2.

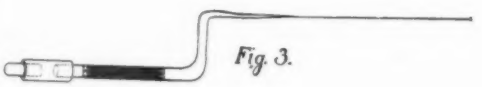


Fig. 3.

When prepared in this way the capillary tube containing the culture was so flat that it was possible to examine the whole contents of the tube under a $\frac{1}{12}$ oil immersion objective.

Eight such tubes were prepared, and four of them preserved at the room temperature, the other four being placed in the incubator where the temperature was maintained at 35° C. They were examined at intervals of 15 minutes, 1 hour, 2½ hours, 21 hours and 24 hours. In no case could any locomotion of the bacilli be detected.

After two and a half hours the bacilli were present in

greater numbers than when the cultures were first introduced into the tubes, showing that the conditions were favorable for their multiplication. At the end of 24 hours the number had increased enormously, and there were two small bubbles of gas in one of the tubes which had been kept in the incubator.

It might, perhaps, be thought that the chilling, occasioned by removing the tube from the incubator for the purpose of examining its contents under the microscope, would be sufficient to check the locomotion of the bacilli, before a clear view of them could be obtained. That this was not the case is shown by the fact that in all the tubes the bacilli soon subsided to the bottom, leaving the bouillon above them free from bacilli. If the tube was turned a little about its long axis and kept in that position for a time, the bacilli settled towards the lower side of the tube.

These observations appear to demonstrate that this bacillus does not possess the power of locomotion, even under anaerobic conditions.

MULTIPLE TUBERCULOUS ULCERS OF THE STOMACH, WITH A REPORT OF THREE CASES.

By Alice Hamilton, M. D.

[*From the Pathological Laboratory of the Johns Hopkins University and Hospital.*]

Tuberculous ulcer of the stomach is conceded by all writers on pathology to be of extremely rare occurrence, some indeed of the earlier ones considering that organ almost immune from tubercular infection. Again, some few of the earlier writers claim to have found it with comparative frequency in the autopsies of tubercular subjects; but as their results vary so greatly from those of the large majority, one is forced to believe that they have included cases of simple ulcer among the number. Förster, Rokitansky, Cornil et Ranvier, Ziegler, Orth, Birch-Hirschfeld and Klebs are unanimous in declaring the extreme rarity of this lesion.

Single cases purporting to be of this disease are reported from time to time in the literature, but it is impossible to accept all of these as actually cases of tubercular ulcer. As the greater number were reported before the discovery of the bacillus tuberculosis, one does not expect to find the diagnosis resting on its presence; but in many of these cases no histological examination was made, and in others no details of such examination are given. All such cases must be dismissed as doubtful or merely probable. Only those can be classed as proven where the report shows by a detailed description of the results of the microscopic examination that the histological characteristics of tubercle were present and which were confirmed or not, as the case may be, by the demonstration of the bacillus tuberculosis.

The earliest of these is Litten's. It was a case of tuberculosis of lungs and peritoneum with no lesion in the intestines, but with a single ulcer in the anterior wall of the stomach, which on microscopic examination showed typical caseating tubercles with giant cells. Talamon also describes tubercles found in the walls of ulcers in the stomach of a child which had died of pulmonary tuberculosis. In this case the ulcers were seven in number, scattered over the surface from cardia to pylorus. Bréchemin's case resembled Litten's in presenting no lesion in the intestines. There was a single ulcer—its location not mentioned—with thickened edges and a floor covered with nodular elevations consisting of "caseated masses surrounded by embryonic and lymphoid cells." Eppinger's two cases are described in great detail and are interesting in being the first cases of multiple ulcer which have been accurately reported. Here, too, the intestines in both cases were intact. The first one was a case of general miliary tuberculosis, and the stomach contained many miliary tubercles as well as innumerable small losses of substance in the mucosa. These ulcers had hard, elevated, regular "rampart-like" walls, and their bases were covered with whitish granulations, which on section proved to be caseated. His description of the microscopic appearances leaves nothing to be desired in either of the cases, the second resembling the first very closely.

Barbacci's case showed tuberculosis of lungs, peritoneum and intestines, besides which the stomach contained five ulcers near the pylorus, two of them having a diameter of 6 cm. These showed nodules of embryonic cells with caseation in the centre. The case of Pozzi is not quite positive. He found an ulcer near the greater curvature in the stomach of a man who had succumbed to pulmonary and intestinal tuberculosis. The walls and base of this ulcer showed no nodules, only "diffuse tubercular tissue." As it was impossible that the diagnosis here should be confirmed by the discovery of the tubercular bacillus—the case was published in 1868—it must be regarded as somewhat doubtful. Duguet's case of a single ulcer near the pylorus in a phthisical patient is so obscurely described that one can come to no definite conclusion about it. Marfan rejects it in his résumé of tubercular lesions of the stomach.

Coats was the first to demonstrate the bacillus in a gastric ulcer. His case, a child with pulmonary tuberculosis, presented numerous losses of substance in the mucosa of the stomach, and the examination showed not only the histological elements of tubercle, but also the specific bacillus. Serafini, Musser and Mathieu et Rémond also found the bacillus in their cases. Mathieu et Rémond's case goes to swell the list of those which showed no lesion in the intestine.

J. Kühl reports four cases from the Pathological Institute at Kiel. He examined all for the tubercle bacillus, but failed to demonstrate it in the two older specimens which had been a long time in the museum. Nevertheless, the histological appearances in the first of these cases point quite positively to tuberculosis; in the second his description is too scanty and obscure to place it above question. The third and fourth instances, which were recent, are described as containing caseating nodules with tubercle bacilli. R. G. Hebb and G. Lava

report each a case of single ulcer—at the lesser curvature and at the pylorus respectively—and describe the microscopic findings as tubercles with caseation and giant cells. It is to be regretted that these observers failed to make any search for the bacillus tuberculosis. This omission is still more striking in Letorey's otherwise exhaustive description of a case of diffuse ulceration near the pylorus. He states that tubercle bacilli were found in the lungs and in the diseased part of the femur, but seems not to have looked for them in the ulcers, where he, however, found typical caseating nodules.

In the following cases it is difficult to decide whether the lesions described are really tubercular or not, the authors having satisfied themselves of the correctness of their diagnoses, but having failed to establish them by giving the facts on which they were founded. So, for instance, Hattute merely states that his case showed "elements of tubercle in the granulations." Lorey, Anger, Matthieu, Cazin and Beadles give no details at all. Finally, a large number must be utterly rejected as, according to the explicit statement of the authors, no microscopic examination was ever made. Such are the cases of Bignon, Paulicky, Chvostek (four), Hebb (second case), Lange, Barlow and Quénu, which last rests for its diagnosis on a mere statement of the author, no description of its macroscopic appearance being given. Several others which have been placed in the list of tubercular ulcer were really miliary tubercles in the walls of the stomach. Kühl's fifth case is an example, also Barth's. Labadie-Lagrave's case showed a cicatrix near the lesser curvature, its tubercular origin being merely hypothetical. Oppolzer's is described as a perforating ulcer connecting stomach and colon, supposedly of tubercular origin, but it was impossible to say in which organ it originated. This covers all of the authentic literature so far as I have been able to discover, and it will be seen that it contains fifteen undoubted cases and nine more which are probable but not proven.

The two cases which I wish to report are, I think, undoubtedly tubercular, although neither could be considered as strictly typical. Indeed, the histological findings in the second case were so little suggestive of tuberculosis that, had it not been for the discovery of the tubercle bacillus, I should not have ventured to class it as tubercular, but the large numbers of bacilli present leave no doubt that they were the prime factor in causing the ulcerative process. The first case, which contained very few bacilli, presented an appearance that was much more characteristic of tuberculosis. I will omit the histories of these cases, which offered nothing of special interest, merely stating that both patients were admitted to the Johns Hopkins Hospital, to the service of Dr. Osler, in the advanced stages of pulmonary phthisis. The autopsies were performed by Dr. Flexner, from whose reports I will give merely the essential points.

Case 1. Colored female, aged 30 years. The right lung contained near the apex a cavity about the size of a small walnut, with smooth walls; the lung tissue adjacent was densely infiltrated and converted into a caseous mass. In the lower portions of the upper lobe, beneath the anterior surface and near the middle line, a small cavity existed with smooth walls which communicated freely with the bronchi. Its walls were caseous, and adjacent to it were large caseous masses surrounded by œdematous and congested tissue, which often presented a gelatinous appearance. The upper portion of the lower lobe was taken up by a series of cavities, more or less communicating, the deepest of which extended almost to the pleura, and was separated from this only by thin granulation tissue in which could be seen many opaque tubercles. Over this cavity the two layers of the pleura were adherent. The dependent portion of this lobe anteriorly was drawn out to a tongue-like appendage in which were caseous masses, the intervening lung tissue presenting a gelatinous appearance. Firm, dry and caseous tissue surrounded the cavity in the upper lobe, and most of the remainder of this lobe was converted into similar tissue. The lower lobe contained scattered caseous foci, while the pleura covering all of the left lung was scattered over with gray and opaque tubercles. The bronchi, larynx and trachea showed numerous superficial losses of substance reaching only through the mucous membrane. This ulcerative process in the larynx extended to the mucous membrane of the mouth and tongue, but did not pass to the œsophagus. The bronchial lymphatic glands were pigmented, enlarged and caseous. Tubercles were observed in the liver and kidneys.

The intestines were the seat of numerous ulcerations, which occurred at intervals, beginning 165 cm. below the duodenum and extending to within 10 cm. of the rectum. They were partly circular, partly elongated—"girdle-ulcers"—and penetrated to the muscular coat. In many, small tubercles were visible in the depth. On the peritoneal surface a few tubercles were seen. The appendix vermiformis was free from ulceration.

The stomach showed a large number of losses of substance, from 115 to 120, scattered over the entire organ, but most thickly on the anterior aspect near the greater curvature. These ulcers were round or oval, usually smaller than a penny, with rounded thickened edges, generally smooth and undermined for a variable distance.

The chief interest for our purpose centers in the ulcerations existing in the stomach. Our studies embraced the examination of many of these, often in serial sections, both with respect to their pathologic histology and to the presence of tubercle bacilli. Ulcers of various sizes were sectioned, stained and examined microscopically. The details are purposely omitted. The ulcers vary in their histological appearances, depending somewhat upon the extent of their development. Even in the youngest and most superficial the glandular elements are much disturbed, and a considerable proliferation of cells has taken place in the mucosa. The cells are small, round and lymphoid in type, but among them are also some which have the character of epithelioid cells. The deeper ulcers show a greater number, even a preponderance, of cells of an epithelioid habitus, and an arrangement at times into nodules of the size and roughly of the appearance of miliary tubercles, whose centres are formed by epithelioid, and whose peripheries by lymphoid elements. Giant cells were not discovered. On the other hand, necrosis of cells existed with fragmentation of nuclei, and, within the new tissue, even larger areas suggesting definite caseation. The nodules with central necrosis were sometimes in the mucous membrane, perhaps in

the overhanging edges of the ulcers, and again upon the floor formed by the submucosa, which was always found when exposed to be infiltrated with new cells, partly lymphoid, partly epithelioid in character. The thickened, undermined edges showed an increase of spindle-shaped cells, suggesting a new growth of connective tissue, forming at times a decided band. Tubercle bacilli (Ziehl-Neelsen method of staining) appeared in small numbers along the free surface of the ulcers, and singly, imbedded in the tissues, among the clusters of epithelioid cells.

Case 2. Male, colored, age fifty years. The right lung was bound by adhesions to the chest wall and the diaphragm, and the lobes were bound to each other. On section the whole lung was quite consolidated. Old fibrous processes extended in all directions through the lung, but they were most abundant posteriorly and at the apex. Small foci of caseation partly calcified were found, and in addition actual cavities lined with thin pyogenic membranes, the largest of them not exceeding the size of a walnut. The bronchial glands were enlarged, caseous and partly calcified.

The left lung, on the other hand, was free from adhesions except at the apex, the upper lobe was retracted at the apex, slaty in color and contained caseous masses, but elsewhere this lobe was quite smoothly consolidated. The lower lobe was voluminous, congested, containing very little air. In some smaller branches of the pulmonary artery partly decolorized thrombi existed, without infarction. Both bronchial and mediastinal glands were enlarged and caseous.

The small intestines were free from ulceration, but in the patches of Peyer in the ileum near the valve there were several elevated gray nodules, about the size of bird-shot or a little larger, with central depression, doubtless small tubercles with loss of substance in the centre. The large intestines were free; the appendix vermiformis contained about its centre an elevated grayish nodule similar to those in the ileum.

The mucous membrane of the stomach was congested and covered with sticky mucus, and along the greater curvature, almost over its entire extent, small losses of substance occurred, 70 to 75 in number. They presented worm-eaten edges and uneven bases, which sometimes, but rarely, were covered with small granulations. They extended usually only partly through the mucosa. The follicles of the œsophagus were enlarged, but without ulceration.

The histological and bacteriological examinations of these ulcers were carried out in the same manner as in the preceding case, fourteen of the ulcers in all being subjected to study. For this purpose ulcers of various sizes were chosen. With the exception of two or three, those examined involved only the upper layers of the mucous membrane, and the deepest ones did not extend beyond the muscularis mucosæ. The edges of these ulcers were never deeply undermined, and the infiltration of the mucous membrane passed a very little way only beyond the ulcerations. In general the appearances presented were those of superficial and small ulcerations, whose floor was formed by the infiltrated mucous membrane, still showing glands or vestiges of glands, but in which the proliferation of cells had so altered the latter that they were often with difficulty recognizable. The new cells consisted chiefly of the lymphoid variety, and they were diffusely scattered, but epithelioid or larger cell elements were not entirely absent. Only once was a perfectly distinct nodule, the size of a miliary tubercle, discovered, and this consisted of epithelioid cells more centrally and lymphoid more peripherally placed. On the other hand, in the floor of the ulcer it was possible to distinguish more nodular formed masses of lymphoid and epithelioid cells, but definite and typical tubercles, in the usual sense, were entirely wanting. The free surface of the ulcers showed more or less necrosis; the deeper layers, which were in an excellent state of preservation (the tissue having been perfectly fresh), were quite free from such indications. Tubercle bacilli were present in great numbers; in no section were they wanting, and often they occurred in great clumps. The main masses were on the free surface of the ulcers, but they were also found deeper down among the glands or within their lumina.

The foregoing cases seem to possess sufficient interest to warrant recording them, even though it is now admitted generally that the stomach at one time or another becomes directly involved in tuberculosis of the alimentary tract. It is interesting to consider for a moment a fact alluded to by many writers, that there is a want of correspondence between the appearance of lesions of a tuberculous nature in the stomach on the one hand and in the intestine on the other. While in the great majority of cases the latter shows great disposition for the development of tuberculous ulcers, it is interesting and striking to see how often in the cases reported in the literature, where ulcers existed in the stomach, the intestines entirely or almost entirely escaped. Every pathologist must be impressed with the unexpected variations in the localizations of tuberculous lesions, and must have observed instances in which the alimentary tract entirely escaped infection when the conditions seemed most favorable for it. It is impossible at the present time to give any satisfactory explanation of such occurrences.

Concerning the multiple nature of the ulcers in the two cases discovered above, they are in this respect, compared with other cases (except Eppinger's), peculiar. It is questionable whether they may be considered as having shown any special predilections for situation, except in the second case to avoid the pylorus, apparently the most common seat of single ulcers. Two points may be considered in this connection, one of which is borne out by the bacteriological examination of the second case. The size of some of the ulcers and their limitation to the mucous membrane agree not a little with the small erosions following ecchymoses into the mucosa, the so-called hemorrhagic erosions. The absence of a specific histological structure peculiar to tubercle, in many of the more superficial losses of substance, is not inconsistent with such an origin. That such erosions are very common in many diseases is of course well known, and it may therefore with propriety be asked whether a part of the ulcers in the second case do not owe their origin to this cause, and the tubercle bacillus is responsible only secondarily for a further destruction; the production of those lesions more nearly resembling histological tubercles. Eppinger long ago declared that the œsophagus was invulnerable to the tuberculous virus, unless a

previous lesion existed to enable it to get a foothold; and while this statement has perhaps been disproven, yet that such a previous injury may act as a predisposing cause is more firmly established now than when he wrote (see Cordua). And if for the œsophagus, it may be asked why not for the stomach? The facts in our second case point more towards such a view, namely, that many small erosions, probably of hemorrhagic origin, existed in the stomach, some or all of which became invaded by tubercle bacilli swallowed with the sputum, than that they owe their production to a direct invasion, in the absence of a previous lesion, of the mucous membrane of the stomach, by the bacillus tuberculosis.

In closing I wish to express my gratitude to Dr. Flexner for the advice and assistance most kindly given me in the course of this investigation.

Addendum.

After the completion of the above report, a third case of gastric ulcer came under observation, which proved also to be of tubercular origin, and the specific character of which was far more easily determined than in the other two cases. The lesions here conformed in every way most closely to the usual type of tubercular ulcerations. The ulcers were in this case but two in number, of large size, and accompanied by the formation of tubercles which were evident even to the naked eye.

Case 3. The patient was a colored girl of eleven years of age. She entered the medical department of the Johns Hopkins Hospital (service of Dr. Osler) on June 16th. Tubercular peritonitis was diagnosed, and she was transferred to the surgical side, where the diagnosis was confirmed by an exploratory operation, the peritoneum being found covered with miliary tubercles and the intestines matted together. The patient recovered from the operation and lingered until December, when death occurred. The autopsy was performed by Dr. Livingood, from whose report the following extracts have been taken.

The body was much emaciated. Extending from below the costal margin to a point opposite the umbilicus was the scar of an imperfectly closed incision, the floor of which consisted of a sloughing surface covered with pus. Near the umbilicus the tissues were darkened and necrotic in appearance. On attempting to open the peritoneum, the transverse colon and the upper part of the omentum were found completely coherent. Below, the intestines were closely matted together by fibrinous and fibrous bands, which could be stripped apart, though with difficulty, especially at the umbilicus. The parietal layer of the peritoneum was thickened and studded with conglomerate and miliary tubercles. The peritoneal cavity contained a large amount of turbid, yellowish-white fluid with fine flocculi. It had a slightly fæcal odor. The serous coat of the intestines was studded with numerous caseous tubercles, usually about the size of a cherry-stone, but ranging larger and smaller. The appendix vermiformis was so matted in the mass that it could not be found.

The anterior mediastinal and the lower cervical glands were enlarged and caseous. The visceral and parietal layers of the pleura on the right side were studded with caseous tubercles, some of which reached the size of a bean.

The pleural cavity was partly obliterated by fibrous adhesions. The lung contained in its apex numerous small nodules, some of them caseous; it was congested over the remainder of its extent, and small tubercles could be seen and felt scattered through it. The left pleural cavity was completely obliterated, and the lower lobe of the lung could not be freed from the diaphragm, but had to be removed with it. Miliary tubercles were scattered over both layers of the pleura, especially thickly along the lines of the ribs. A large area of caseation was formed where the lung was in contact with the diaphragm, and this process seemed to have extended directly through the diaphragm to the spleen and liver beneath. The upper lobe of the left lung showed more extensive tuberculosis than did the right lung, being filled with numerous tubercles in all stages of caseation, but without definite cavity formation. Small nodules were scattered through the lower lobe, which was much congested and, at its lower extremity, in the early stage of consolidation.

The spleen was adherent to the diaphragm and to the parietal peritoneum. Its capsule was thickened and was the seat of large caseous tubercles, but there were no distinct tubercles in the substance. One small caseous tubercle was found in the right kidney. The mucous membrane of the uterus was the seat of a number of yellow and gray miliary tubercles. Both tubes were enlarged and adherent to the surrounding structures. Some of the lymphatic glands in the broad ligament were caseous, and the vaginal mucous membrane contained a single tubercle. The capsule of the liver was covered with numerous minute tubercles, and others were found in the substance of the organ. The pancreas was closely adherent to the caseated retroperitoneal lymph glands, and its substance showed large caseating areas.

The stomach was adherent to the transverse colon, the pancreas, and to the mass of enlarged peripancreatic lymph glands. The serous coat was covered with small and large caseous tubercles. Midway between the pylorus and the cardia on the posterior aspect of the lesser curvature, was a large, irregularly oval, crater-like erosion, 3 cm. by 2 cm. in size. The edges were raised and somewhat undermined and more deeply congested than the surrounding parts. The floor was irregular, the deepest part of the crater measuring 8 mm., while the remainder was formed by projecting caseous tubercles. Directly behind this ulcer was a caseous lymphatic gland, so closely adherent to the stomach wall at this point that it was impossible to tell whether or not it formed the floor of the ulcer. A second smaller erosion was found above this one, in the middle of the lesser curvature. Its edges were slightly elevated, and in one place deeply undermined, the floor being formed by the muscularis. Here and there scattered through the mucous membrane were minute grayish white and yellow points looking like, but not proven to be, miliary tubercles. In the duodenum, just beyond the pyloric orifice, was a large ulcer with caseous tubercles covering its base; a similar but still larger one was found in the cæcum, and smaller ones scattered through the small intestines.

In the microscopic examination of the larger of the two gastric ulcers, the section passed also through the adherent lymph gland, which was found to be completely necrotic. It

was intimately adherent to the stomach, separated only by the remains of the muscular wall from the caseous masses within the stomach wall proper. The mucous membrane for quite a distance around the ulcer was infiltrated, becoming more or less necrotic at the edges, which were elevated and undermined. The deepest part of the ulcer had for its floor the muscularis, but the walls were formed by large caseous tubercles, some of which were completely necrotic. In the overhanging edge, which was formed by mucosa, and throughout the mucosa generally, were found small tubercles which, for the most part, had originated in the submucosa or muscularis mucosæ. They represented all stages of tubercle formation. Giant cells were present in great numbers. Sections stained by the Ziehl-Neelsen method showed numerous tubercle bacilli, both in the superficial and deep layers.

In this case the question naturally arose whether or not the ulcerative process in the stomach was merely secondary, having been caused by the adherent lymph gland which had ulcerated through to the free surface. The microscopic examination proved, however, that the process in the stomach was quite independent in its origin, as the still intact muscular wall could be traced along the whole extent of the ulcer between it and the caseous gland behind.

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STUDIES ON TRICHINOSIS.

By T. R. Brown.

[Abstract of remarks and discussion before the Johns Hopkins Hospital Medical Society.]

The clinical history of the case which forms the basis of these remarks resembles in some respects the classical picture, though the symptoms were unusually mild. The patient, a man 23 years of age, was admitted to the hospital on March 3, 1896, complaining of general muscular pains. He had been ill six weeks, and for the two weeks before entry the pain had been so severe that he had scarcely been able to move about. There were irregular fever and extreme muscular tenderness, particularly in the arms and legs. The diagnosis of a myositis, probably due to trichinosis, was made and confirmed by the finding of actively motile trichinæ in pieces of muscle removed from the arm.

He remained in the hospital for over two months, being discharged well.

During his stay in the hospital the blood was examined daily. The number of leucocytes per cm. was determined and a differential count was made of the various forms; frequent examinations of the urine were made with quantitative determinations of the uric acid, urea and total nitrogen. The two small pieces of muscle which were removed were subsequently subjected to careful microscopical examination. The results of the studies may be summarized as follows:

(*a*) ***The blood.*** The study of the blood was carried on continually during the course of the disease, a determination of the leucocytes and a differential count of the various forms of leucocytes being made daily. The result of these observations showed: (a) A gradual rise of the proportion of eosinophiles, reaching 68.2 per cent—35 per cent. higher than any previous record—and from this point a gradual decline to 16.8 per cent. on the patient's discharge; (b) a coincident depression of the polymorphonuclear neutrophiles, reaching at one time 6.6 per cent., while for two weeks these forms showed an absolute decrease in the blood, notwithstanding (c) the marked leucocytosis, reaching on some occasions above 30,000 per cubic millimetre.

In fact, the neutrophiles and eosinophiles showed at all times an inversely proportional relation, and the eosinophilic rise could be seen to be distinctly at the cost of the neutrophiles, the other forms showing relatively little fluctuation.

The presence of such quantities of eosinophiles suggests their possible diagnostic value in trichinosis, and perhaps, if it be found on further studies to be characteristic of this disease, may help to clear up the cases which are regarded *intra vitam* as rheumatic in nature and which, years afterward, the autopsy table shows to have been cases of trichinosis.

As an association has for a long time been noted between

the eosinophiles and the Charcot-Leyden crystals, various experiments were made with the blood which contained such large quantities of eosinophiles, to see if the crystals could be derived directly from these cells. In all cases, however, the results were negative, seeming to show that the crystals are, at least, not direct crystallization products from the eosinophiles, but that something besides the presence of these cells is necessary for their formation.

(*b*) *The urine.* The quantitative determinations of the uric acid, urea and total nitrogen were carried on mainly in connection with the ideas of Horbaczewski, that the uric acid, derived from the destruction of nuclein-holding material, comes normally in large part from the leucocytes and is therefore increased in leucocytoses.

Although the uric acid per 24 hours was determined on 23 different days, and on four of these the urea and total nitrogen also, on no occasion did the total uric acid excretion, or the relation between the nitrogen of the uric acid to that of the urea or to the total nitrogen exceed the normal limits, showing that the views of Horbaczewski are not universally correct. In this case, however, the leucocytosis differed somewhat from the ordinary in that here the eosinophiles were the cells markedly increased; in his cases the ordinary polymorphonuclear neutrophiles.

(*c*) *The muscle.* The changes in the muscle were extensive. There was a great proliferation of the muscle nuclei throughout the section; about the fibres containing trichinæ this proliferation was very marked, especially in the second specimen; not so extensive in the earlier specimen. In fact, in a few places where the parasite had but just wandered into the primitive bundle no change in the muscle substance nor any proliferation of nuclei was visible. Most of the fibres containing the worm showed a conversion of the muscle substance into a finely granular faintly-staining material containing many large swollen nuclei, *i. e.* the proliferated muscle nuclei; and about many of the proliferated nuclei, both in the more and in the less degenerated portions, distinct vacuoles could be made out.

Throughout the specimens the muscle showed various forms of disintegration, in some places a longitudinal splitting of the fibres into fibrillæ, in other places the formation of what might be called muscle cells, the muscle nucleus taking about itself some of the muscle substance and separating itself from the fibre; while in still other places a peculiar transverse splitting up of the muscle into disks, the nuclei here proliferating transversely instead of in the usual longitudinal method, was noted.

Besides these changes there were seen in the first specimen many polymorphonuclear cells, some showing a finely granular protoplasm which did not stain to any extent with acid stains (the so-called neutrophiles), some distinct eosinophiles with large deeply-staining granules, and beside these, cells which somewhat suggest transitional forms, showing in the protoplasm of the cell body fine granules, but with a distinct affinity for the acid stain; and all these cells seemed to be acting as phagocytes in the disintegrating muscle, being often seen in little lakes or bays in the degenerating bits.

In the second specimen there were decidedly fewer neutrophiles and many more eosinophiles than in the first. That in both cases these were typical eosinophiles was shown by staining them in the different acid stains and in the Biondi-Heidenhein triple stain.

At the same time with this greatly increased proportion of eosinophiles in the extra-vascular leucocytes in the muscle, *the blood-vessels in the interfascicular connective tissue showed the same proportion of neutrophiles and eosinophiles as was found in the blood count for that day.*

In another specimen of muscle from a case of acute trichinosis which was obtained from the pathological museum, great quantities of eosinophiles were also found.

The study of the blood, showing the steady increase of the eosinophiles at the expense of the neutrophiles, together with the identical character of the nuclei of the two forms, would tend to support the view held by some observers, that the former variety of cells is derived by some transitional change from the latter.

That such a change might take place in the muscle is suggested by the presence here of neutrophiles, eosinophiles, and what may be regarded as transitional forms, in large quantities. Particularly suggestive is the great disproportion between neutrophiles and eosinophiles seen in the second muscle specimen. Here the eosinophiles were much increased, the neutrophiles correspondingly decreased, while the blood-vessels in the interfascicular connective tissue showed but the same proportion of these forms as was to be made out in the specimens of the peripheral blood for the same days. It is further noteworthy that the eosinophiles increased in number soon after the increase in severity of the muscle symptoms, and shortly after the decrease of those symptoms, diminished gradually, descending toward the normal point as the symptoms abated. Suggestive also is the presence of large numbers of eosinophiles in a specimen of muscle from another case of acute trichinosis.

Dr. Osler.—This is the only case of trichinosis which has been in the hospital, or it is safer to say the only case recognized, since we know that not infrequently the disease escapes recognition or is mistaken for some other disorder. This is the second case which I have seen clinically, while in the post-mortem room I have found on eight or ten occasions the calcified cysts. Mr. Brown is to be congratulated on the very thorough way in which he has followed this case.

Dr. Thayer.—The evidence offered by Mr. Brown in favor of the origin of the eosinophilic cells by transition from the so-called neutrophiles is very suggestive. The total number of polymorphonuclear cells found in the circulating blood was practically what one would expect in a leucocytosis of that extent. And yet, examining this percentage which normally should consist almost absolutely of so-called neutrophilic leucocytes, we find the great majority represented by eosinophiles. The fact also that in the affected parts the blood-vessels contained the same relative proportion of eosinophiles and neutrophiles as did the peripheral vessels, while the tissues round about contained an enormously greater percentage of eosinophiles, is very interesting.

That the so-called neutrophilic granules stain often with acid coloring matters is well known. With good acid dyes

these granules almost always take a slight stain, and by some observers both eosinophiles and neutrophiles are classed as acidophilic cells. They stain, however, much better in fluids consisting of a mixture of acid and basic coloring matters. As Mr. Brown has sharply pointed out, this acid staining of the smaller granules was not to be made out at all in the specimens of blood and in the blood-vessels in the tissues, and the fact that outside of the vessels in the affected parts numerous apparent transitional forms between the non-granular polymorphonuclear wandering cells and the true eosinophiles existed is very suggestive. That these cells were true eosinophiles in the sense of Ehrlich, Mr. Brown has proven by careful tests with a number of different acid coloring matters.

The idea that the eosinophiles represent a further change in the cell which we know as the neutrophile is, as Mr. Brown has said, not a new one, but I am not aware that any argument in favor of this view as forcible as that which he presents has yet been published.

With regard to the actual blood condition—the increase of the eosinophiles—no similar case exists in the literature; the percentage of eosinophiles in this instance is more than twice as large as has been reported in any other case.

Dr. Barker.—Mr. Brown has referred, in speaking of the degeneration of the muscle, to a splitting up of the muscle fibre into transverse disks. I should like to ask him whether or not he has been able to make out just where the splitting occurred. Though several histologists have emphasized the fact, it does not appear to be generally known that the splitting in the muscle fibre may occur with some reagents at one level, with other reagents at an entirely different level. Thus in the formation of the so-called Bowman's disks through the action of alcohol, the two layers Q (doubly refractive substance of Brücke) with the layer M (Hensen's line) in between are always present in the disk. On the other hand, on treatment of muscle with certain acids (acetic, picric or hydrochloric), the splitting occurs between the two layers Q, each disk having then in its middle the layer Z (Krause's transverse line or membrane). It would be interesting to know, for the degeneration described, whether the splitting occurred at either of these two levels or at still another level.

I gather from his paper that Mr. Brown favors the view that the eosinophile granules represent the cyto-mikrosomas of the cells in which they occur. This view, recently supported by Lovell Gulland, was previously urged by Martin Heidenhain, who found that the eosinophile granules stain black with his iron-hæmatoxylin staining method, and that it is often possible to make out an arrangement of the granules radial to the attraction sphere of the cell. Both these observations are in favor of the cyto-mikrosomal nature of the granules.

The occurrence of such an enormous number of eosinophiles in the circulating blood is truly remarkable and makes the case unique in the bibliography.

PROCEEDINGS OF SOCIETIES.

THE JOHNS HOPKINS HOSPITAL MEDICAL SOCIETY.

Meeting of December 7, 1896.

Dr. Thayer in the Chair.

On Certain Visceral Pathological Alterations, the Result of Superficial Burns.—Mr. Bardeen.

Extensive superficial burns are followed by severe constitutional symptoms. The great pain felt at first is followed by a benumbing of the senses and by sleepiness. At times there may be delirium and cramps. The pulse becomes weak, the respiration shallow and irregular. The temperature, after a short rise, falls below the normal. There may be vomiting and diarrhœa, and hæmoglobin may appear in the urine. Death within 48 hours usually follows a burn which has involved two-thirds of the surface of the body. The burn need not be of an extreme grade. Death has often followed burns so superficial as to give rise merely to an erythema.

It is clear from this latter class of cases, at least, that alterations in the internal organs may follow the burning of the skin which cannot be accounted for on the supposition that they are directly caused by the heat. Thus arises the question as to the nature of the physiological relations between the lesions produced in the skin and the resulting constitutional effects. Many hypotheses have been advanced to answer this question, some of which have been supported and others destroyed by experimental work on animals.

Many of these hypotheses have been based upon the conception of a loss of normal cutaneous activity. But experiment has shown quite conclusively that death after burns is to be ascribed neither to the retention in the blood of products normally excreted through the skin, nor to heat radiation due to paralyzed blood-vessels in the latter structure.

Again death has been referred to changes produced in the blood itself directly acted upon by the high temperature. It is known that erythrocytes are destroyed by a comparatively low temperature (55° C.). This has led to the supposition that the general pathological effects are due to loss of functional red blood corpuscles, or to irritation produced in the kidneys and other internal organs by the products of their disintegration. But a more generally accepted view is that the blood is so altered by the elevation of temperature as to give rise to extensive thrombosis, death resulting from the disturbances of circulation.

Another view has been advanced more recently. Kijanitzen, who extracted from the blood of dogs experimentally burned, substances similar to Brieger's ptomains, and Reiss, who found toxic substances in the urine of persons accidentally burned, believe that they have brought forward evidence in support of the idea that the blood in severely burned animals is rendered toxic.

During the past year five small children were brought to the Johns Hopkins Hospital so severely burned that death in each case followed within a very few hours of the accident. At the suggestion of Dr. Flexner I took this opportunity of studying

the histological alterations found in the tissues of the body after burns. A careful autopsy was made in each case by Dr. Flexner, and parts of the various organs were preserved and prepared for microscopic examination.

The lesions in all five cases were strikingly similar. Of the gross lesions the most notable were cloudy swelling of the liver and kidney, acute swelling of the spleen, and swelling and congestion of the lymphatic glands and other lymphatic tissue.

Microscopically, the most interesting lesions noted were parenchymatous degeneration of the kidneys and liver, focal areas of necrosis in the liver, and pronounced focal necrosis in the lymphatic tissue.

The lymphatic tissue was affected throughout the body. The Malpighian corpuscles of the spleen, the tonsils, gastric lymphatic follicles, enteric solitary and agminated follicles and the lymphatic glands all showed essentially the same changes.

The lymphatic glands were much swollen and at times congested. The earliest changes were in the follicles and consisted of an œdematous swelling. This was more marked towards the centre of the follicle, in an area corresponding to the germinal centre. In areas of less advanced alteration the lymphocytes were merely less closely packed together than is usual. But in the areas of more marked change, the lymphocytes were swollen and their nuclei fragmented. In these cases the follicle presented a remarkable appearance. It was not only greatly swollen, but at the edges a rim of closely packed lymphocytes existed, while at the centre swollen and distorted lymph cells, bits of protoplasm and fragments of nuclei were seen scattered about, some lying free, others enclosed in large flat endothelioid cells.

The lymph cords as well as the follicles were swollen, while the lymph sinuses seemed less distinctly marked off than usual from the reticulum in which the lymphocytes of the cords lie imbedded. Here and there throughout the gland groups of degenerating cells might be seen, but the areas of distinct focal degeneration were confined as described above, to the follicles.

Calvert has shown that the terminal artery breaks up in the centre of the follicle into capillaries which radiate towards the periphery of the follicle. It seems possible that the lesions focalized just at this region may in some way hold special relation to the circulation of the blood. For if the blood in these cases contains toxic materials, it is conceivable that it is just at the centre of the follicle that the poisonous plasma acts with greatest intensity on the lymph cells.

In the lymphatic follicles of the tonsils and stomach and in the Malpighian bodies of the spleen focal degeneration essentially similar to that of the follicles of the lymphatic glands occurs. In the intestines the greatly swollen lymphatic follicles, solitary and agminated, showed extensive focal areas of degeneration.

In these areas of degeneration in the lymphatic tissue we find appearances essentially similar to those seen after the injection into the body of various bacterial and other toxalbuminous substances. Indeed, the lymphatic glands from our cases of skin-burn might readily be mistaken for the lymphatic glands of children dead of diphtheria. The lesions in the other organs are also essentially similar to those found in the bodies of persons dead from the acute infectious diseases. It seems, therefore, justifiable to consider that one of the main causes of death after burns is to be sought in a toxæmia caused by alterations in the blood and tissues, the direct effect of the elevation of temperature; a view which is further strengthened by the clinical evidences and the experimental work of Kijanitzen and others.

NOTES ON NEW BOOKS.

The American Year-Book of Medicine and Surgery: being a yearly digest of scientific progress and authoritative opinion in all branches of medicine and surgery, drawn from journals, monographs and text-books of the leading American and foreign authors and investigators. Collected and arranged, with critical editorial comments, by J. M. Baldy, M. D., and twenty-six other physicians, under the general editorial charge of George M. Gould, M. D. (*Philadelphia*, 1897: *W. B. Saunders*, 925 *Walnut Street*.)

This year-book amply justifies the high expectations which were excited by the excellent character of the similar volume published last year. It is an encyclopedic collection of new medical literature gathered from all lands and every field of medical knowledge. It is not a mere aggregation, but a discriminating digest of the latest knowledge in medicine, with frank opinions and critical comments by painstaking and competent men. The special comments of the editors as distinguished from the authors are enclosed in brackets, to facilitate reference to them.

The completeness of the department of medicine, which has had the editorial supervision of Pepper and Stengel, is shown by the fact that it covers more than 180 pages. Among other interesting matter the sections on the Schott method, typhoid fever, malaria and myxedema are probably of the most interest. In view of the extravagant claims for the different methods of aborting typhoid fever, it is gratifying to notice that the authors ask that all cases treated by these methods be more carefully studied and the symptoms more minutely described.

Under the head of surgery, which occupies 248 pages of the volume, Keen and DaCosta give a valuable résumé of the most recent work in anæsthetics, with sensible comments upon the dogmatic assertions of many experimenters. It is refreshing to read the following: "Wunderlich, from a statistical study, concluded that albuminuria was more apt to be induced by chloroform than ether. Beck from a statistical study concluded that albuminuria was most apt to be caused by ether. We are thus confronted by carefully compiled reports which are diametrically opposed and absolutely contradictory. The humble surgeon who venerates statistics too much to use them is lost in uncertainty. We are told that figures cannot lie, and yet only one of these statements can be true. Which is the truth we cannot yet decide, as we know of no birthmark to prove identity."

The operative treatment of perforation in enteric fever would seem to be presented in too gloomy colors, in the light of Finney's recent statistics.

The article on diseases of the gall-bladder is quite full and satisfactory. The same may be said of the careful and conservative article on the use of the *x* rays.

Obstetrics, under the editorship of Hirst and Dorland, occupies about 100 pages, and presents many topics of special interest to the general reader, notably the sections on the pathology of pregnancy, abortion and extra-uterine pregnancy.

The section on gynecology, by Baldy and Dorland, occupies upwards of 200 pages, and touches upon a variety of interesting

matter. The objection presented to Clark's radical operation for the relief of uterine cancer, that but few patients can endure the shock of the prolonged etherization, seems hardly tenable in the light of actual practice. The chapter on nervous and mental diseases, by Church and Patrick, is thoroughly well worked out, and presents a good review of the work of the past year. The section on materia medica is an excellent feature of the book. All things considered, the book is well arranged, admirably edited and well printed. Every physician who does not have leisure to inform himself on the latest advances in medicine and surgery from original sources, should procure and carefully read the volume.

Architecture of the Brain. By Wm. Fuller, M. D., Grand Rapids, Michigan. 1896. Pages 1-183, with many illustrations.

In this volume are described and pictured the general gross relations of the brain as seen (1) from the external surface, (2) on dissection, and (3) in a series of frontal sections. The author has had a large experience in dissection of the central nervous system and in the preparation of castings in plaster of the dissections which he has made. No person except one who has busied himself in work of this kind can easily estimate the amount of labor which has preceded the publication of the book.

After a description of the membranes, the cerebro-spinal axis as a whole is described. The cerebrum is then taken up and the method of dissecting it outlined. A discussion of the structure of the cerebellum, of the pons varolii, of the medulla oblongata and spinal cord follows. Throughout the book the main stress is laid upon the gross morphology, but there are brief chapters concerning the nerve tracts of the cerebro-spinal axis and the central origin and relations of the cranial nerves. On pages 130–133 there is a brief discussion of topographical cerebral localization. L. F. B.

Annual Report of the Supervising Surgeon-General of the Marine Hospital Service of the United States for 1893. Vols. I and II. (*Washington: Government Printing Office*, 1894–1895.)

These volumes present a very complete and satisfactory account of the operations of the Marine Hospital Service for 1893. The most valuable papers are a carefully prepared account, by Surgeon Stoner of Baltimore, of the origin and development of this Service, which should be read by all who desire to familiarize themselves with its history, and the "Report of the Commission to Investigate the Cholera Epidemic," prepared by Dr. Walter Kempster and Surgeon Fairfax Irwin, who made an extensive trip in Europe to procure data for it. It is to be regretted that the Commission, while entering into very great detail as to its operations, does not formulate and publish its conclusions in connected form. Scattered throughout the report are many valuable suggestions touching the prevention of infectious diseases and the transmission of contagion, which can only be found by reading many unimportant details. These should have been gathered in an accessible form, so that they might be easily read.

Medical and Surgical Report of the Presbyterian Hospital in the City of New York. Vol. I., January, 1896. By Andrew J. McCosh, M. D., and Walter B. James, M. D. (*The Knickerbocker Press, New York.*)

This report is the first of a series. It is carefully edited and well illustrated. Many of the papers are carefully written and of great interest to the general profession. The pathological reports are meagre and the protocols published are in most instances brief abstracts. Several of the papers have appeared elsewhere. One of them, that of Dr. Northrop, on Gonorrhœal Arthritis, is more popular than scientific, and portions of it read as if the author were thinking aloud. The results of thinking rather than mental operations would be preferable. Taken as a whole, the surgical papers seem to be of the greater value. The volume, however, is worthy of the institution from which it issues and the high character of its editors. It is to be hoped that it will have an annual successor.

BOOKS RECEIVED.

Transactions of the American Gynecological Society. Vol. 21. 1896. 8vo. 490 pages. Wm. J. Dornan, Printer, Philadelphia.

Prize Essays on Leprosy. By Newman, Ehlers and Impey. 1895. 8vo. 227 pages. New Sydenham Society, London.

Practical Notes on Urinary Analysis. By William B. Canfield, A. M., M. D. Second edition. 1896. 12mo. 106 pages. G. S. Davis, Detroit, Mich.

A Pictorial Atlas of Skin Diseases and Syphilitic Affections. In photolithochromes from models in the Museum of the Saint-Louis Hospital, Paris. With explanatory woodcuts and text. By E. Besnier, A. Fournier, etc. Edited and annotated by J. J. Pringle, M. B., F. R. C. P. Fol. Parts IV and V. 1896. W. B. Saunders, Philadelphia.

Lectures on Pharmacology for Practitioners and Students. By Dr. C. Binz. Translated from the second German edition by Arthur C. Latham, M. A., M. B. Oxon., M. A. Cantab. Vol. 1. 1895. 8vo. 389 pages. The New Sydenham Society, London.

Autoscopy of the Larynx and the Trachea. (Direct Examination without Mirror.) By Alfred Kirstein, M. D. Authorized translation (altered, enlarged and revised by the author) by Max Thorner, A. M., M. D. 1897. 12mo. 68 pages. The F. A. Davis Co., Philadelphia.

The Practice of Medicine. By James Tyson, M. D. 1896. 8vo. 1184 pages. P. Blackiston, Son & Co., Philadelphia.

Anomalies and Curiosities of Medicine. By George M. Gould, A. M., M. D., and Walter L. Pyle, A. M., M. D. 1897. 4to. 968 pages. W. B. Saunders, Phila.

A Pictorial Atlas of Skin Diseases and Syphilitic Affections. In Photo-Lithochromes from Models in the Museum of the Saint Louis Hospital, Paris, with explanatory woodcuts and text. By E. Besnier *et al.* Edited by J. J. Pringle, M. B., F. R. C. P. Part VI. 1896. W. B Saunders, Philadelphia.

A Treatise on Cholelithiasis. By B. Naunyn, M. D. Translated by Archibald E. Garrod, M. A., M. D., F. R. C. P. 8vo. 197 pages. 1896. The New Sydenham Society, London.

Principles or Guides for a Better Selection or Classification of Consumptives Amenable to High Altitude Treatment and to the Selection of Patients who may be more Successfully Treated in the Environment to which they were Accustomed Previous to their Illness. By A. Edgar Tussey, M. D. 1896. 8vo, 144 pages. P. Blakiston, Son & Co., Philadelphia.

Twentieth Century Practice. An international encyclopædia of modern medical science, by leading authorities of Europe and America. Edited by Thomas L. Stedman, M. D. Vol. X. 1897. 859 pages. 8vo. Wm. Wood & Co., New York.

Transactions of the College of Physicans of Philadelphia. Third Series. Vol. XVIII. 1896. 8vo. 263 pages. Printed for the College. Philadelphia.

Injuries and Diseases of the Ear. Being reprints of papers on otology. By Macleod Yearsley, F. R. C. S. 12mo. 1897. 40 pages. The Rebman Publishing Co., Ltd., London.

The American Year-Book of Medicine and Surgery. Being a yearly digest of scientific progress and authoritative opinion in all branches of medicine and surgery, drawn from journals, monographs and text-books of the leading American and foreign authors and investigators. Collected and arranged, with critical editorial comments, by J. M. Baldy, M. D., *et al.* Under the general editorial charge of George M. Gould, M. D. Profusely illustrated. 4to. 1897. 1257 pages. W. B. Saunders, Philadelphia.

Inebriety. Its Source, Prevention and Cure. By Charles Follen Palmer. 12mo. 1897. 109 pages. Fleming H. Revell Co., New York.

The Medical Annual and Practitioner's Index. A work of reference for medical practitioners. Fifteenth year. 1897. 12mo. 851 pages. John Wright & Co., Bristol.

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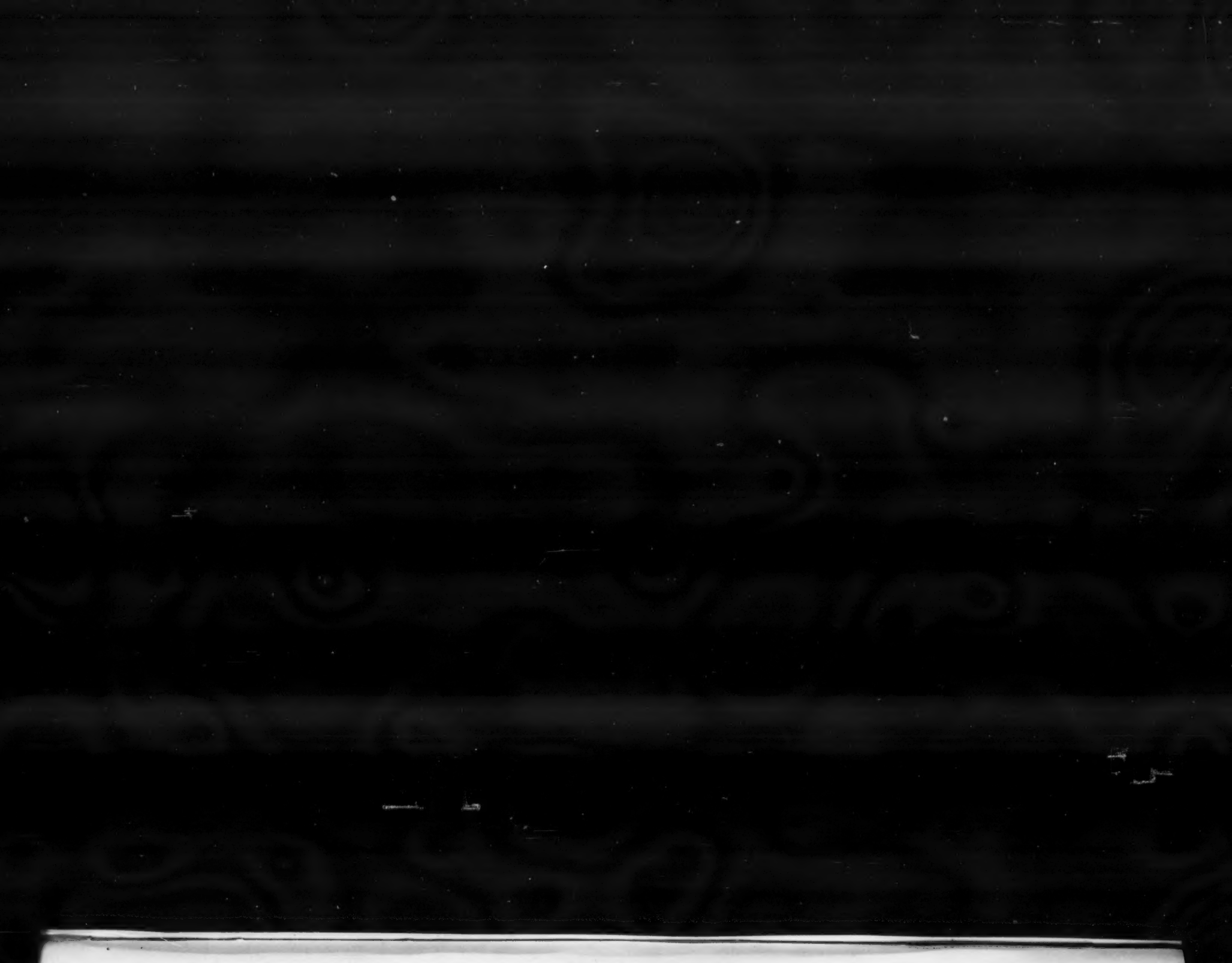
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